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VHA

Mining

THE

MINING MAGAZINE:

DEVOTED TO

Mines, Mining Operations, Metallurgy, &c., &c.

EDITED BY

WILLIAM J. TENNEY,

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VOL. VIII.—JANUARY, 1857.—No. I.

ART. II.—THE IRON MANUFACTURE OF GREAT BRITAIN—THEORETICALLY AND PRACTICALLY CONSIDERED. By WM. TRURAN, C. E. No. 10.

(Continued from page 344, vol. 7.)

SECTION XIII.—ON THE USE OF RAW COAL IN BLAST FURNACES.

THE enlargement of the throat of the furnace, as advocated in the preceding section, will be attended with another advantage, scarcely inferior to the direct saving of fuel. It will enable all the coals now employed in iron smelting to be used in the raw state. At the present day, a few only are considered suitable for use raw; the others have been tried, but failing to give satisfactory results, have been condemned as unfit for blast furnace purposes unless previously coked. In this section we shall examine into the causes which have contributed to the general, though erroneous, opinion, that certain coals are more applicable to smelting in their raw state than others.

As appertaining to the subject we shall briefly describe the characteristics of the principal coals wrought for iron making; and then proceed to show, that all are equally applicable in the raw state, and may be so used with advantage to the yield, make, and quality of the resulting crude iron.

The coals used for smelting may be divided into four classes:—1, the bituminous; 2, the semi-bituminous; 3, the semi-anthracite; and 4, the anthracite.

Of the coals used, however, the largest number come under the denomination of bituminous; with the exception of a portion of the iron made in the South Wales basin, the entire number of furnaces are wrought on this coal. It is distinguished from the others by the large quantity of volatile matter which enters into its composition. When slowly heated its bulk is increased from 20 to 35 per cent. In coking the quantity of tarry matter evolved during the process binds together the pieces in large masses, from which circumstance it is sometimes termed a caking coal. The large percentage of tarry matter enables the small to be advantageously coked in ovens, a peculiarity belonging only to coals of this class.

The yield of coke from a given weight of coal varies with the character of the coal, mode of coking practised, and care exercised during the operation. In the South Wales district the yield ranges from 75 per cent. in the Rhondda valley; to 50 per cent. at the eastern outcrop in the neighborhood of Pontypool. In Dean Forest, Staffordshire, Shropshire, Yorkshire, Northumberland, and Scotland, this coal loses during conversion into coke from 30 to 55 per cent. of its weight.

The semi-bituminous class comprise but few coals, being limited to such as are found located between the bituminous and anthracite coals, but partaking more of the characteristics of the former than of the latter. They contain an inferior quantity of tarry matter. When heated, their expansion of volume ranges from 5 to 15 per cent. They may be converted into coke, but owing to the diminished yield of tarry matter do not cohere in large masses. The yield of coke averages 75 per cent. The small is incapable of coking into masses with the natural proportion of tarry matter.

The semi-anthracite embrace the coal immediately contiguous to the great anthracite formation. When heated they increase in bulk from 5 to 10 per cent. They are converted into coke; but, owing to the reduced yield of tarry matter, it is deficient in strength. The yield ranges from 60 to 75 per cent. The small does not bind, and is incapable of being coked into masses, except by the addition of tar.

The anthracite coal is distinguished by its superior specific gravity, deficiency of tarry matter, and absence of flame during combustion. When its properties are better understood it will rank as the most valuable coal which this country produces. It expands very little when heated. During conversion into coke a minimum quantity of volatile matter escapes; hence, the resulting coke amounts to from 80 to 90 per cent. by weight of the original coal. From the deficiency of tarry matter the small does not cohere to form large cokes.

Our remarks will apply principally to the Welsh district; containing, however, coal of such varied character, they will be equally applicable to the other iron-making districts.

We will premise, that, when raw coal is charged into a furnace, the temperature to which it is exposed causes a distillation of its volatile constituents, leaving a porous coke, differing from the coke prepared in heaps or ovens, only by its superior density. This increase of density results from the coal having been subjected to pressure during the distillation. Whatever coal is used, the evolution of the gaseous products is effected in the upper part of the furnace; at or before reaching the level of the boshes it is converted into a porous coke, the degree of porosity depending principally on the quantity of gaseous matter evolved during the process.

The general composition of the coals in the respective classes may be seen by referring to the analysis in section 1; where, in the case of the South Wales coals, the Pontypool may represent the bituminous; the Dowlais four-feet coal the semi-bituminous; the Hirwain furnace coal the semi-anthracite; and the Yniscedwyn the anthracite.

The bituminous coals are generally coked previous to entering the furnace. They have been tried in the raw state, but their general tendency to cake, and thus obstruct the blast, necessitated a return to coke. The increase of bulk which they underwent also operated unfavorably on the furnace. Increasing from 20 to 35 per cent., when heated, on being precipitated into the high temperature of the throat, the sudden expansion of the large pieces of coal in a confined space caused obstructions to the descent of the materials. The scaffolds thus formed remained suspended until a partial combustion of the coal having been effected, the diminution of volume allowed of their descent.

The semi-bituminous coals are used in the raw state. Undergoing but a small increase of volume when heated, and containing an inferior quantity of bituminous matter, the non-liability to cake in the furnace has been considered a sufficient explanation of their superiority over other coals. Their use is confined to the Rhymney, Dowlais and Penydarran works, and the supply for each of these works is drawn from the same mountain.

The semi-anthracite are coked before entering the furnace. This is the case at the Cyfarthfa, Plymouth, Aberdare, Gadleys, and Hirwain works. They have been tried in the raw state, but the results were not satisfactory. At the Cyfarthfa furnaces the experiment of using raw coal was persevered in for some months. The greatest drawback was found in the accumulation, in the hearth, of quantities of unconsumed small coal. As only lumps were charged, this constant depositing of small coal, produced by the splintering of the large masses, showed a deficiency of binding matter. The loss of carbon in this way, and the additional labor which it entailed, being considered of greater value than the advantages accruing from using the raw coal, recourse was again had to coke.

The anthracite is used in the raw state. For many years attempts were made to use it in smelting, but from inattention to its composition and characteristics they were not successful. Recently, however, it has been largely used in smelting, and although the consumption is unnecessarily large, the fact of its applicability to smelting purposes has been satisfactorily demonstrated.

On reviewing the effects produced in the furnace by the different coals, some curious anomalies are observed. The first is coked because it contains too much bituminous matter; the second is used raw, the proportion of bituminous matter apparently being favorable; the third is coked because it contains too little bitumi-

nous matter; while the fourth, though nearly devoid of this substance, is used in the raw state.

Hence, it follows, that, if the composition and characteristics of the coal determines its fitness for use in the respective states of raw or coked, coals containing either a maximum or minimum per centage of bituminous matter require coking, while those containing a medium quantity, or which are altogether devoid of it, may be used raw.

With the practical smelter, and indeed with the theoretical writer also, the opinion is current, that the failure of the experiments to use the bituminous and semi-anthracite in the raw state advantageously, arose from the peculiar composition of these coals. Having tried the raw coal instead of coke, and ascertained that its use deteriorated the quality, and otherwise was attended with disadvantageous circumstances, it was but natural to pronounce it as unfit for the furnace in this state.

But does the fault lie in the coal? May not the form of the existing furnace be the acting cause of the inferiority of the raw coal? If it is used, a process formerly performed in the coke yard is transferred to the interior of the furnace. Is the interior form of the furnace favorable to the conversion of the coal into coke with a minimum loss of carbon?

The most striking circumstance in connection with the numerous attempts to substitute raw for coked coal, is seen in the fact that the experiments invariably were made in furnaces built for coke. Generally these had narrow throats, and even with coke possessed a high temperature. What must then have been the temperature on substituting a more inflammable fuel!

With a narrow throat furnace, the inevitable consequence of substituting raw bituminous coal for coke would be a sudden increase of temperature, followed by a partial combustion of the coal. The heat formerly existing may not have been very injurious to the coke, for this substance requires a high temperature for its combustion, which then proceeds slowly; but on the raw coal it produces very different effects. Immediately that it enters the furnace the tarry matter ignites, the intense draught and high temperature thereby attained is communicated to the coal, which rapidly expands in volume. The evolution of tarry matter proceeds, the masses cohere together, diminishing the area for the ascent of the heated gases; in the available space the draught is largely augmented, and, acting on the surrounding ignited coal, combustion is effected with great rapidity. The expanded volume of the coal, and its cohering together in large masses, cause frequent scaffolds in the throat: these do not subside until a considerable portion of the carbon is consumed. Hence, the quantity retained for combustion in the hearth is below that which is requisite for the effectual carbonization of the metal. The resulting crude iron, therefore, is of an inferior quality, and owing to

the irregularities in the working of the furnace, the make is diminished.

We do not see the justice of pronouncing this coal as unfit for use in the raw state; yet it is so considered, and coking is universally practised. The sole cause of the inferior produce is the high local temperature prevailing in the throat. With an enlargement, the temperature would be reduced in an inverse ratio to the increased area, and the coal could no longer cake into masses sufficiently large to obstruct the entire area of the larger throat. With the lower temperature also, the evolution of tarry matter, and the conversion of the coal into coke, will proceed more slowly; yet, owing to the slower descent of the materials in the enlarged throat, the process will not be prolonged to a lower level.

In some furnaces raw bituminous coal is used in mixture with coke. By itself, it is reported, that this coal cannot be used advantageously. If the raw coal is prejudicial to the quality and make, it is difficult to understand how its partial use can be other than proportionately injurious. Where raw coal forms any considerable portion of the burden, we observe that the throats are above the average diameter. From this circumstance, we look on the partial use of raw coal in these furnaces, not as evidence that it is unsuitable when forming the entire burden of fuel, but as a proof, that, with the dimension of throat in use, a larger quantity cannot be worked so advantageously.

The general proportion, in the bituminous coal district, is two-fifths of the diameter of the furnace for the diameter of the throat. With cokes there must be a large waste of carbon from this cause; but when raw coal is used, the proportion which the quantity unnecessarily consumed bears to that available for the reduction of the ore is still greater.

The impossibility of converting the raw bituminous coals into cokes, in the throat and upper part of the furnace, as at present constructed, other than with a large waste of carbon, will be apparent, if the intense draught to which they are subjected is considered. We have shown in a previous section, that, in the throat, the velocity varies from 47 to 201 feet per second, according to the area provided for its escape. With a proportion of two-fifths of the diameter of the body, the velocity, with the volume of blast commonly employed, will be 73 feet per second, or 50 miles per hour. The ignited coal is for several hours exposed to a draught little inferior to this: under such circumstances, then, nothing short of combustion of a considerable portion of the carbon can occur.

How very different is the operation of coking on the yard and in ovens! There the injurious effects of the slightest draught on the quality of the resulting coke, being more readily seen, are well known. Immediately that the coal is thoroughly ignited, the draught is diminished, and finally destroyed. If allowed to con-

tinue, the additional loss, through combustion of the carbon, is shown in the reduced weight of coke obtained. The principle observed throughout, is the ignition and distillation of the volatile gases in such a manner that a maximum volume of carbon shall remain.

At the Rhymney, Dowlais, and Penydarran works, the change from coke to raw semi-bituminous coal was made without any attendant disadvantageous circumstance. The coal expands less in volume, and contains a smaller percentage of bituminou smatter; but the principal circumstance in its favor was the comparatively large throat at the furnaces in each of these works. The mean diameter is equal to half the diameter of the furnace. Hence, the comparatively cool throat. Scaffolding however is not unfrequent in these furnaces; and, with the advantages accruing from the additional area, the consumption of coal, as we have shown in the preceding section, is fully twice that required for the reduction of the ore.

That a wasteful combustion takes place in the throat of these furnaces cannot be questioned, if the changes presented by the coal while uncovered are carefully noted. Immediately that it enters the furnace, the small projecting angles ignite, and in a few seconds attain a white heat; this is communicated to the remainder of the mass already highly heated; active combustion commences, and proceeds until the coal is covered with other materials, when it is deadened but not destroyed. The great updraught continues to support combustion, but as the coal descends this diminishes in intensity, until at the boshes it is at a minimum.

The evils of a high temperature in the throat are equally manifest in furnaces using semi-anthracite coal. Deficient in tarry matter, the liability to cake and obstruct the blast does not exist, but this very deficiency entails other drawbacks of scarcely less importance. Precipitated into a high temperature, the sudden expansion of the outer portions results in their detachment from the central mass; on the separation of the first portion, a repetition occurs of the unequal heating resulting in the detachment of others; hence, the volume of carbon in the original mass is largely reduced, and unless of a very homogenous structure, is finally split into two or more pieces. The bulk of the small detached pieces are consumed in the throat, but a portion descend in a charred state to the hearth, where their presence entails additional labor on the attendants, and loss of time in their removal.

These disadvantageous circumstances have caused this coal to be denounced as unfit for use in the raw state, and at the several works we have named coking is deemed an indispensable operation. Yet the splintering of the raw coal in the furnace is merely so much evidence that the sudden high temperature communicated to it is too much for the continuity of its particles, and not of

its unfitness, if the operation were otherwise conducted. In the coke yard this coal is converted into coke with no more than the average loss. What are the circumstances which prevent its being coked in the blast furnace? In the coke yard, the temperature of ignition is attained very slowly, is the work of some hours, but in the narrow top furnace it is communicated in a few seconds. The violent evolution of gas which then takes place, coupled with the expansion of the outer portion, destroys the continuity of its particles. The highly bituminous coals are charged into red-hot ovens without apparent injury to the coke produced, but if the same mode of coking is attempted with this coal, the splintering into fragments, and consequent waste of carbon, is scarcely inferior to that produced by the high temperature of the furnace throat.

The obvious remedy for this splintering and weakening of the coal is a reduction of temperature in the throat, and as this can only be done by diminishing the draught, the enlargement will enable these coals to be used in the raw state with the best results.

The successful employment of anthracite coal in the blast furnaces, dates from a very recent period. In the early part of the present century it was attempted to be used for smelting, but unsuccessfully. The desirability of using it for this purpose, however, was apparent, and after repeated failures, anthracite is now used with partial success.

When the means, by which the smelters in the anthracite district sought to solve the problem of smelting with this coal are considered, their insufficiency for the attainment of success is very apparent. In the experiments, the greatest pressure of blast employed did not exceed 1¼ lbs. to the inch. With a fuel of such dense structure as anthracite, it is not surprising that the experiments were for a period unsuccessful. The inferiority of the blast was of itself a sufficient cause for the failure. But if to the weak blast, there be added the disadvantage of employing furnaces constructed for burning the coke of bituminous coal, it is very evident that however desirous of using this coal, the arrangements adopted were not such as could tend to success.

The anthracite displays the deficiency of bituminous matter in a greater degree than the coals around Merthyr Tydfil, and when precipitated into the high temperature of the narrow throat furnace, the sudden accession of caloric results in the partial disintegration of the coal. The detached pieces descended to the hearth and formed an obstacle to success in the early experiments. At the present day this accumulation of carbonaceous matter in the hearth, is a serious disadvantage attending the employment of anthracite.

The furnaces in which the experimental trials were made had the usual narrow throat, but in those recently erected, the throats are constructed of a diameter larger in proportion to that of the

boshes, than in any other furnaces. The general proportion, as will be seen by referring to the Plate of blast furnace sections, is two-thirds of the greatest diameter. Consequent on the enlargement to this proportion, the facility of smelting with anthracite has been increased, the temperature in the throat is not so great as formerly, and the injury to the coal being reduced in the same proportion, an increased burden is carried. But as a farther reduction of temperature cannot be other than highly advantageous to the coal, by the more gradual communication of caloric reducing the tendency to splinter and disintegrate, and allowing the entire mass to be converted into a dense coke, the enlargement of the throat to the diameter of the boshes will be productive of great advantage.

If reference is made to the proportion which the throat bears to the diameter of the furnace, it will be seen that for every 100 feet of horizontal area in the furnaces in the bituminous district, the throat has an area of 16 feet; in the semi-bituminous and semi-anthracite, the proportion is increased to 25 feet; in the anthracite to 44 feet. Furnaces with a proportion of 25 feet are unable to smelt advantageously with a coal deficient of bituminous matter unless previously coked; but when the proportion is increased to 44 feet, the pure anthracite is used raw.

We have hitherto advocated an increase to the diameter of the boshes, forming the upper part of the furnace cylindrical, but as in the case of anthracite, we cannot proceed too cautiously in communicating an increase of temperature in furnaces for smelting with this coal, the enlargement may beneficially be extended until it is one-fourth or one-third greater than the boshes. Consequent on this enlargement, the velocity of the ascending column of gases will be reduced four-fifths, and a minimum temperature maintained.

By a large class of persons in the trade it is supposed that anthracite cannot be advantageously used unless with a heated blast. This is an error, and arose from the defective blowing machinery originally employed. To show the insufficiency of the first blast we may mention that there is a patent extant for using a cold blast of more than 2½ lbs. to the square inch. With a cold blasts of this, or greater density, large quantities of cold blast iron have been smelted. But while furnaces having the contraction at top are employed, the heated air will be the most economical in the yield of coal. The diminished volume of blast employed consequent on the caloric thrown into the furnace, causes a diminished draught and reduced temperature at top, favorable to the yield.

The saving of coal which must attend any arrangement by which the raw coal is enabled to be advantageously used, combined with the reduced consumption of carbon consequent on the reduction of temperature, will reduce the cost of smelting full one

half. In the bituminous coal districts of Monmouthshire, the conversion of the coal into coke is attended with such waste, that, from 3½ to 4 tons of coal are required for each ton of foundry iron produced. The carbon ranges from 76 per cent. in the inferior bituminous varieties to 92 per cent. in the anthracite. The present system of coking before entering the furnace is attended with the combustion of from 10 to 50 per cent. of the carbon in the coal. Since the volume of carbon determines the value of the coal for smelting purposes, the retention and combustion of the entire quantity in the furnace will be attended with a proportionate yield of caloric.

The altered form of furnace will permit of raw coal being used, and by economizing the caloric, and retaining the entire quantity of carbon for combustion in the hearth, 20 cwts. of raw coal will be more effective than 3½ tons converted into coke and afterwards consumed in furnaces of the present form.

The widening of the top so as to insure a reduced temperature, will be highly advantageous to the smelting with compressed peat. Large tracts of this valuable fuel exist in the vicinity of deposits of the richest iron ores, but hitherto the attempts to use it in the blast furnace have failed. The best specimens contain quantities of volatile matter, and unless previously well dried, injurious quantities of water; their rapid evolution in furnaces of the present form, causes a greater or less destruction of the coal, while from the high temperature maintained, a portion of the carbon is consumed. In the same proportion as the coal is weakened and carbon consumed are its carbonating powers reduced, and the yield per ton of iron augmented. But owing to the moisture and generally large percentage of ash, the increased consumption is fatal to the economy of smelting with this coal. The large quantity of ash deposited requires for its fusion a corresponding dose of limestone; hence, the quality of the iron is contaminated by the excess of earthy matter added for fluxing. With the improved form of furnace, the diminished temperature at top will favor the retention of carbon, and being subjected to a great pressure long before its temperature is elevated to a red heat, the continuity of its particles will be insured, and the ability of the charred peat to support a blast of the requisite density will be little inferior to that of charcoal.

Although of secondary importance compared with the saving of fuel, the enlargement of the furnace in the manner detailed will be highly beneficial to the smelting operations, when raw or imperfectly calcined ores are employed. The effect produced on the materials in the furnace by these ores is, that of rendering latent a large quantity of the caloric evolved by the fuel. By the absorption of caloric, the water and volatile matters in the ores are expelled, accompanied by a reduction of temperature in the surrounding materials. Time is required for the perfect

calcination of the ore, and if the materials descend very quickly the operation is completed at a low level, diminishing in a similar ratio the time allowed for the deoxidation. By widening the throat, however, the velocity of descent will be largely reduced, and the gradual expulsion of the gases and complete calcination of the ore effected, in a region where the heat rendered latent will not injuriously affect the working of the furnace.

Calcination is now almost limited to the carbonates of the coal formations: a form of furnace in which the water in combination with the primary ores is evaporated in the upper stratum of materials, will greatly facilitate the production of carbonated crude iron from these ores.

With raw limestone also, the caloric rendered latent with the evolution of carbonic acid and water, occurring at a higher level, a superior temperature will be maintained in the furnace.

To smelters of carbonaceous ores the altered shape of furnace will be of great value. The percentage of carbon in ores of this class frequently exceeds that of the metallic iron, and more than suffices for its reduction. With the present system of calcination in clamps, the carbon is nearly consumed in an operation wherein one-fifth or one-sixth of the quantity would suffice. In the wide throat furnace this ore may advantageously be used in the raw state, and the carbon in mechanical combination be made available for the reduction of the ore.

Finally, we may add that the necessity for calcination of ores, generally, has arisen with the form of furnace employed for their reduction. The operation properly belongs to the blast furnace; and in furnaces of a form different from those now employed, may be performed more economically and advantageously in the throat than in kilns or other independent erections. The labor, coal, and capital expended in the present system of calcination may be saved, with every advantage to the quality and quantity of the resulting crude iron.

Section XIV.—Blowing Engines.

The blowing engines now employed for supplying blast to the furnaces and refineries are generally of an improved construction, compared with those existing at the commencement of the present century. Larger engines are employed, and worked at higher velocities with a diminished consumption of coal, labor, and repairs. Water was formerly extensively used as a motive power in compressing the blast, but the irregularity of supply, and limitation of power common to all hydraulic blowing machines, has resulted in its general abandonment, and the substitution of steam.

But though much improved in their construction, blowing engines are, with very few exceptions, greatly behind the requirements of the manufacture. The number in use is about 310, and from a personal examination of the majority, we con-

sider them as inferior in make and power, and more expensive in their maintenance, than the high state of mechanical engineering would have warranted. A deficiency of power is nearly an universal defect. When it is considered that the success of the operations in respect to quality, produce, and economy, is dependent in a great measure on the blowing engine, the necessity of having superior engines of ample power, and maintained in the first working order, is very apparent. But iron-masters generally are not practical engineers, and much of the inefficiency observed in their engines must be placed to the credit of the makers.

With the majority of manufacturing engineers, a blowing engine is treated as a machine, in the construction of which, second and third-rate workmanship and inferior materials are all that is required; but a greater mistake can hardly be committed. The limited number of engines of this description at work may account in part for this neglect, but we apprehend that ignorance of the important bearing which the efficiency of the engine has on the success of the manufacture, is the principal cause. There are numerous works wherein a breakage would probably entail the loss of the blast furnaces. It is but a short period since an accident of this kind occurred at the Dowlais works to an engine constructed in this manner, which had nearly resulted in the setting of the materials in 4 furnaces. It was only by unremitting exertion, and the circumstance of a large foundry and machine shop being on the premises, that the furnaces were saved.

In the construction of a blowing engine, the design, workmanship, and materials should be such, that the liability to accidents and derangements is reduced to the narrowest limits. The utmost regularity in the working is demanded. A blowing engine differs from all others, inasmuch that its operations are continuous: every stoppage, from whatever cause, is attended with greater or less loss to the manufacturer. The engine being of sufficient power, its value to the manufacturer is directly dependent on the time which it will work without requiring renewal or adjustment of any part, or any other operation involving a stoppage. In the case of locomotive, marine, and other engines, opportunities are afforded for repairs and other operations connected with the engine, requiring time for their completion; but with blowing engines it is different. The blast is on the furnace months and years, with only a few minutes interruption weekly; the full engine power is therefore demanded so long as the furnace continues in blast.

With the knowledge, then, of how much success depends on its efficiency, a blowing engine should be constructed so as to work a month without stopping, and then for an hour only. Once in two or thee years a stoppage of a few hours will be required;

but as a rule, no really efficient engine need stop more than 30 hours in a year for current repairs. We have found this sufficient, and believe that with care it may be considerably abridged with advantage to the operations of the furnace.

Formerly all the engines were low pressure condensing, having an air pump, cold water pump, nozzle containing 5 or 6 valves, and a complicated working gear. This make of engine is still in use at several works, but while comparatively new, they require frequent small repairs which necessitates stoppages of greater or less duration, and after working a few years, cannot be kept in an efficient working state with less than 5 or 6 hours weekly. But owing to the complicated gearing, accidents of a minor description are of frequent occurrence; the sudden cessation of blast on such occasions is attended with greater expense and more injurious effects on the furnace, than stoppages at stated intervals, for which preparations may be made.

The majority of the engines recently constructed are of the high pressure non-condensing class, and where the latest improvements have been adopted in their construction, the expansive action of the steam has been availed of, and a corresponding economy in their working expenses obtained. The substitution of high pressure steam has enabled the engines to be constructed with less than the one-third of the number of working parts formerly required; with this greater simplicity of the working parts the liability to accident and derangement has been proportionately reduced.

The employment of high pressure engines has resulted in a greater uniformity in the density of the blast discharged at the tuyeres. With the ordinary condensing engine, the dead stop at the end of each stroke caused a corresponding depression in the blast. This in the high pressure class is obviated in a great measure by the employment of a heavy fly wheel, which carries the engine over the centres, and produces with the same number of strokes per minute a discharge of blast much superior to the other in point of regularity. For this reason, the workmen attending the furnace give the preference to a blast from a high pressure engine as being steadiest.

The adoption of the high pressure system has been productive of other advantages,—the density of the blast for instance is unlimited, and when the superior reducing power of a blast of greater density than is ordinarily attainable with other engines is fully appreciated, engines of this description will become general. In the old condensing engine there is a limit to the density of the blast attainable with the common proportion of cylinder. The low pressure of the steam employed,—3 to 4 lbs. to the square inch above the atmosphere,—placed the diameter of the blowing cylinder within certain limits. The mean working pressure on the steam piston, including the vacuum, averaged

about 13 lbs. to the inch, but after deducting friction and leakage, the working power given off rarely exceeds 10 lbs. Hence, in determining the size of the blowing cylinder in proportion to that of the steam, engineers were guided by the density of the blast,—as much as this was below the available steam power so much larger was the area of the blast cylinder. By common consent the maximum blast pressure was fixed at 2½ lbs., or one-fourth of the steam pressure; consequently the blowing cylinder was augmented in diameter until its area was 4 times that of the steam cylinder. With these proportions the pressure of the blast could never exceed 2½ lbs., when the engine was in the best working condition; but owing to leakage, defective supply of steam, and imperfect condensation, it frequently fell below this density, and the mean working effect could not be rated higher than 2 lbs.

The early double acting engines were constructed to work at a velocity of 180 to 200 feet per minute; with the enlargement of the blast furnace a larger volume of blast was demanded, and the velocity was increased to 260 and 300 feet, and in some instances 400 feet per minute. At this velocity the delivery of blast was doubled, but the rapid action of the engine more than quadrupled the accidents and stoppages; in addition to which, the greater wear increased the leakage of the pistons and valves, and by giving less time for the condensation rendered the engine less able to maintain the blast at the previous density.

With the high pressure engine there is no practical limit to the density of the blast attainable. Engines having cylinders similarly proportioned to those at condensing engines, are capable of compressing the blast to a pressure of 8 to 10 lbs. to the square inch, and owing to the absence of all injurious concussion may be driven at double the usual velocity with less wear and leakage. We have found a velocity of 660 feet per minute to cause less injury to these engines than 250 feet to others on the low pressure condensing principle.

In point of economy the high pressure engine merits the preference. The first cost, the power at a given speed being equal, is nearly one-fourth less, where an ample supply of water for condensation is at hand; but where provision has to be made, the difference in favor of the high pressure is still greater. And since the high pressure engine may be safely and advantageously driven at double the speed of the condensing engine, estimated on the volume of blast delivered by the respective engines in a given time, the cost of the high pressure is under one-half that of the ordinary low pressure engine.

Compared also by the working expenses of the two systems, and the balance is seen to be equally in favor of the high pressure. The consumption of coals, stoves, repairs and labor is from one-fourth to one-third less than with condensing engines of

similar date of manufacture. At the Dowlais works the cost of a given quantity of blast produced by 4 condensing engines is more than twice the expenses attending the production of a similar quantity with the 4 high pressure engines.

Until within a comparatively recent date, blowing engines, whether on the high or low pressure principle, were constructed with vertical cylinders and a working beam to communicate the power from the steam to the blowing cylinder, and the requisite movements to the condensing and working gear. In several works recently erected, the engines and blowing cylinders are placed in an horizontal direction, thus enabling the beam and several other working parts required with the vertical engine to be dispensed with. Engines of this kind are at work in several Scotch works; in Yorkshire, Derbyshire, Staffordshire, and Wales. In first cost they are the cheapest of any hitherto erected, but in maintenance they appear to be the most expensive. We strongly advocate simplicity, when it does not interfere with the efficiency of an engine; but simplification and reduction in the first cost, which entails stoppages and frequent repairs, is more than compensated for by the ruinous consequences produced in the blast furnace. The high pressure horizontal engines in use, without exception, are more inefficient and expensive engines for maintenance than the old class of condensing, and when the essentials of a good blowing engine are fully considered, the cause is very apparent.

The horizontal plan was first applied to small engines; since the general adoption of such cylinders in locomotive engines, this mode of construction has partly supplanted the beam and vertical cylinder. With engines of the smallest class the change has unquestionably been advantageous,—a point on which we can speak from the experience obtained in the working of between 20 and 30 erected by ourselves within the last few years,—but when applied to engines of the largest calibre, disadvantages of a serious character are developed. The unequal wear of the cylinder, and the rapid wear of the piston, are the greatest defects of horizontal engines. They exist to a greater or less extent in all engines having horizontal cylinders, locomotives included, but are most apparent in large engines. In these, the bearing surface of the piston in proportion to its weight is diminished as the diameter of the cylinder is augmented,—hence the rapid wear of the large engines constructed on this plan. The duration of the cylinders of horizontal engines, before the wear renders re-boring necessary, depends on the hardness of the metal composing the cylinder and piston. The soft metal requires reboring in a comparatively short period:—in the case of a 33 inch cylinder engine, made of Scotch hot blast iron of a soft quality,—after the piston had travelled about 70 millions of feet. The direct wear of the cylinder in this case was nearly $\frac{1}{4}$ inch in

depth in the middle. With harder metal cylinders of a smaller diameter (18 inch), lasted for nearly 300 millions of feet. Locomotive cylinders, taking the working of 10 engines at the Dowlais works, average 350 millions feet. In these three examples the distance traversed by the piston was distributed over from 4 to 10 years, so that the necessity for re-boring and re-fitting occurred at intervals of several years. With these figures it is not difficult to ascertain the length of time which the steam cylinder of an horizontal blowing engine of similar dimensions may be worked without these operations.

The velocity of the high pressure engine may be taken as averaging 400 feet per minute; at this rate the piston will have travelled 300 millions feet in 17 months, consequently the necessity for stopping, re-boring, and a thorough refitting of the engine would occur at intervals of a few months instead of years. The peculiar circumstances under which a blowing engine is required to work, viz., several years continuously, has been overlooked in the application to it of the horizontal construction. It is seen that, measured by the distance travelled by the piston—the only correct index—the wear of a cylinder to an unserviceable point is accomplished in one-fifth of the time usual with engines of this description applied to other purposes.

This of itself is a sufficient reason for the defective performance of this class of engine, but a still greater drawback to their use is found to exist in the working of the blowing piston. It is known to engineers that, in the large steam cylinders worked on this construction, the wear from the friction of the piston is greater than in the small engines. What, then, must be the friction and wear with cylinders and pistons 9 to 12 feet in diameter? In the engines which have been erected, it has been proportionately great. The wear of the horizontal blowing cylinder is much greater than that of steam cylinders of like diameter. In the latter, the tallow or other lubricating material descends to the lower side, where the rubbing occurs, and is there maintained in a fluid state by the heat of the steam. The blowing cylinder is lubricated with blacklead, or a compound of which blacklead forms the chief ingredient, which falls to the bottom, but by reason of the coldness of the cylinder and the passing dust, it collects at the ends, in the rear of the piston, and has little effect in reducing the friction. This difficulty of keeping the rubbing surface well lubricated is made painfully apparent by the romping noise common to such engines. Driven at a higher speed than 250 feet per minute, we have found the vibration created by the friction of the blowing piston so great as to endanger the stability of the engine. To reduce the weight on the cylinder the piston has been constructed of wrought iron, and hard steel bars have been fitted into the lower side of the cylinder to increase its durability. The piston rod has been car-

ried through both covers, with a view of lifting the weight of the piston from off the cylinder, but without any appreciable improvement. A third plan has been adopted, and partially remedies the defect,—the piston is mounted on a small wheel which rolls on the inner surface of the cylinder, and thereby diminishes the abrasion. All these expedients, however, are so much evidence, that the horizontal blowing engines in regard to cost of maintenance and regularity of operation, are inferior to condensing and high pressure engines with beams; and looking to the inherent defects of all engines on this principle, we do not consider it possible, in the present state of mechanical science, to construct an engine with horizontal cylinders to successfully compete with those constructed with vertical cylinders.

In the construction of the vertical cylinder engine, however, there are some points which demand close attention. A very common defect is to make the blowing piston rod too small. Engine makers have assumed that, since the gross pressure on the blowing piston is less than that on the steam, a rod of the same tensile strength will suffice. But in this assumption the larger diameter of the blowing piston, and the consequent greater leverage, and tendency to bend the rod, has been neglected. From inattention to this circumstance the breaking of the rod is not an unusual occurrence. The smallest sectional area of the blowing piston rod should be double that of the steam rod, and one of still larger dimensions is preferable. The vibration of the 9 inch rods at the Dowlais engines is considerable, and eventually diminishes the tensile strength of the metal to the working strain, when fracture occurs.

The area opened by the wind valves for the admission of the air to the blowing cylinder cannot be too large, where a maximum working speed is intended. By having a large area and numerous valves, the duration of the valves and working of the engine will be improved. We find in practice that the wind valves work silently at a speed of 600 feet per minute, when the aggregate area at each end is equal to one-half the area of the piston. The aggregate area of the delivery valves at each end ought to be not less than one-seventh the area of the piston. Valves of one uniform size throughout should be employed; two thicknesses of leather riveted together will suffice, where the seating is crossed by wrought iron bars, reducing the space between the beatings to about 6 inches each way.

The area of the blast pipes should be as large as possible,—as a rule, less than one-seventh of the area of the piston should not be adopted; one-fifth is better; and, by acting as a magazine of compressed air, insures greater regularity in the delivery of the blast.

A diversity of opinion exists as to the merits of different descriptions of packing for the blowing piston; formerly, leather

was universally employed; but with the high velocity at which engines are now commonly driven, this material is not so durable as could be desired. We have adopted hemp and gasket, or oakum packing, screwed down with the common junk ring, which is cast in short segments for convenience of handling, and find that for durability and cheapness it is unequalled. The piston goes 4 or 5 months without calling for examination, and the packing generally is renewed only once in 16 or 18 months.

It is usual to make the working beam so that the stroke at each end shall be equal; in practice, however, the working of the engine is greatly improved by making the stroke in the steam longer than that in the blowing cylinder. By lengthening the steam cylinder the expansive principle may be advantageously applied; and in consequence of the continuous action of the blowing engine, a duty, or performance may be realized, little inferior to that attained with the best Cornish pumping engines, and greatly superior to any thing attainable with the best marine and mill engines.

For attaining a maximum effect the proportions ordinarily followed in the construction of steam engines require to be modified. The area of the passages and valves for the admission of steam should be not less than one-sixteenth of the area of the steam piston. In general it is much less, and the injurious consequences are seen in the comparatively slow speed at which the engines can be driven. At 3 engines in the Dowlais works, the area of the steam valve to the area of the piston is as 1 to 40, 42, and 52 respectively. This is much too small, and under no circumstances can these engines be made to travel more than 280 feet per minute. The boiler power is ample for a speed of 500 feet, but owing to the contracted passage, the full pressure cannot be maintained in the cylinder at high velocities. In the blowing engine erected during our connection with that establishment, we made the area equal to one-twentieth of the area of the piston; this was followed by a speed of 660 feet per minute, —more than doubling the volume of blast which it could have delivered with contracted passages.

As a precaution against accidents, and the ruinous consequences which they entail on the manufacturer, every part of a blowing engine subjected to strain requires to be twice as strong as any other class of engine. In the construction of marine and locomotive engines lightness is an object; but in this class of engines the value of a few tons of metal is trifling in comparison with the losses occasioned by accidental stoppages. The labor consumed is the most expensive item in construction, and is nearly the same, whether the engine is lightly or strongly made; hence the additional cost of the latter over the former is measured by the value of the additional raw material consumed.

The generation of the blast at a cheap rate is an object of im-

portance to the smelter. Coal is probably the heaviest item in the working expenses, and by the quantities consumed we may form an opinion of the comparative efficiency of various engines. To show the room for improvement in the majority of blowing engines, we will state the volume of blast, at a density of 3 lbs. o the square inch, delivered by the following engines, for each lb. of coal consumed.

WINGERWORTH, DERBYSHIRE.—Direct action revolving engine, high pressure steam, driving fans; quantity of blast generated at a pressure of 1½ lbs. to the square inch, 4200 cubic feet per minute. Consumption of coal, 8.6 tons in 24 hours, 13.4 lbs. per minute. Volume of air discharged corrected to a pressure of 3 lbs., for each lb. of coal consumed, 166 cubic feet.

Pair of blowing engines, high pressure, horizontal cylinders; blowing cylinders 48 inches diameter, stroke 7 feet: strokes per minute 12; quantity of air per minute, at a pressure of 2½ lbs., 4221 feet. Consumption of coal per 24 hours, 6.5 tons; per minute, 10.1 lbs. Volume of air discharged for each lb. of coal consumed, corrected to a pressure of 3 lbs., 313 cubic feet.

MONKLAND WORKS, SCOTLAND.—High pressure engine, horizontal cylinders; blowing cylinder 72.2 inches diameter, stroke 9 feet; strokes per minute 18; quantity of air per minute, at a pressure of 3 lbs., 9298 cubic feet. Consumption of coal per 24 hours, 15 tons; per minute, 23.3 lbs. Volume of air discharged, at a pressure of 3 lbs. for each lb. of coal, 400 cubic feet.

GARTSHERRIE WORKS.—Beam engine, low pressure condensing; blowing cylinder 120 inches, stroke 9 feet 6 inches; strokes per minute 16; quantity of air per minute, at a pressure of 2¾ lbs., 24,335 cubic feet. Coal consumed in 24 hours, 35 tons; per minute, 55 lbs. Volume of air for each lb. of coal, corrected to a density of 3 lbs., 405 cubic feet.

CORBYN'S HALL.—Two blowing engines, low pressure condensing; quantity of air per minute, at a pressure of 2½ lbs., 16,185 cubic feet. Coal consumed per 24 hours, 13 tons; per minute, 20.2 lbs. Volume of air discharged for each lb. of coal, corrected to a density of 3 lbs., 622 cubic feet.

HIRWAIN WORKS, BRECONSHIRE.—Low pressure condensing engine; blowing cylinder 104 inches diameter, stroke 7 feet 3 inches; strokes per minute, 16; quantity of air per minute, at a pressure of 3 lbs., 13,688 cubic feet. Coal consumed per 24 hours, 17.2 tons; per minute, 26.5 lbs. Volume of air discharged at a density of 3 lbs. for each lb. of coal, 512 cubic feet.

DOWLAIS WORKS.—No. 4 engine: low pressure condensing; blowing cylinder 108 inches diameter, stroke 7 feet 6 inches; strokes per minute, 17; quantity of air delivered per minute, at a pressure of 2½ lbs., 16,218 cubic feet. Coal consumed per 24 hours, 11 tons; per minute, 17.1 lbs. Volume of air discharged, for each lb. of coal, corrected to a density of 3 lbs., 790 cubic feet.

No. 5 engine: high pressure non-condensing; blowing cylinder 144¾ inches diameter, stroke 9 feet 3 inches; strokes per minute, 13; quantity of air delivered per minute, at a pressure of 2½ lbs. to the inch, 27,476 cubic feet. Consumption of coal per 24 hours, 15 tons; per minute, 23.3 lbs. Volume of air delivered per pound of coal consumed, corrected to a density of 3 lbs., 980 cubic feet.

No. 1 engine (new): high pressure non-condensing; blowing cylinder 144 inches diameter, stroke 12 feet; strokes per minute, 19; quantity of air discharged per minute, at a pressure of 3 lbs. to the square inch, 51,528 cubic feet. Coal consumed per 24 hours, 25 tons; per minute, 38.8 lbs. Volume of air discharged, at a density of 3 lbs. for each lb. of coal consumed, 1328 cubic feet.

From these quantities it appears that the mean of the high pressure beam engines is 1154 cubic feet; of the low pressure condensing engines 560 feet; and of the high pressure horizontal 356.

cubic feet of air compressed to a density of 3 lbs. for each pound of coal consumed. The rotary engine and fan blast may be considered as the least effective form in which the power of steam can be employed for smelting purposes.

By a series of indicator diagrams taken from the steam and blowing cylinders of 8 blowing engines at the Dowlais works, we ascertained that the gross power exerted on the steam piston amounted to 2356 H.P., and the gross resistance offered by the blast 2036 H.P.; hence, the useful effect obtained was equal to 86 per cent. of the power expended.

As showing the proportions adopted in the construction of a well proportioned blowing engine, we subjoin the principal dimensions of the No. 1 engine at the Dowlais works, the largest of its class hitherto erected either in this country or abroad. When driven at a maximum speed the power given off amounts to nearly 1000 horses (33,000 lbs.) 1 foot high per minute to the H.P.

Diameter of steam cylinder, 55 inches.
Stroke of piston, 13 feet.
Diameter of piston rod, 6¼ inches.
Depth of piston, 13 inches.
" stuffing box, 18 inches.
Steam passage, 24 by 5 inches.
Stalk of slide valve, 3 inches.
" expanding valve, 2½ inches.
Eccentric gab pin, 3½ inches.
Stroke of eccentric, 13 inches.
Holding-down bolts, 8 of 3 inches diameter.
Estimated weight of loading under steam cylinder, 2400 tons.
Diameter of blowing cylinder, 144 inches.
Stroke of piston, 12 feet.
Diameter of piston, rod, 9 inches.
Depth of piston at centre, 16½ inches.
" piston at edge, 8½ inches.
" stuffing box, 16 inches.
Area of wind valve passages in cover, 56 feet.
" delivery valve passages in cover, 16 feet.
Diameter of connecting pipe, 4 feet.
" blast main, 5 feet.
Holding down bolts, 7 of 3 inches diameter.
Estimated weight of loading under blowing cylinder, 1760 tons.
Diameter of fly wheel, 22 feet.
Sectional area of rim, 224 square inches.
Depth of centre piece, 2 feet 6 inches.
Weight of fly wheel complete, 35 tons.
Diameter of crank shaft bearing, 19 inches.
Weight of shaft, 10 tons.
Length of crank, 4 feet.
Depth at centre, 16 inches.
" eye, 13 inches.
Sectional area of metal at centre, 384 square inches.
Sectional area of metal at eye, 280 square inches.
Diameter of crank pin, 10½ inches.
Sectional area of metal in wrought straps of connecting rod at crank pin end, 60 square inches.

Girder carriage under crank shaft standard and steam cylinder, 4 feet deep; flanch, 2 feet wide at top and bottom, by 4 inches thickness of metal throughout.
Dressed stone pedestal under beam, 7 feet thick.
Length of beam, steam end, 20 feet 7 inches.
" beam, blast end, 19 feet 6 inches.
Depth of beam at centre, 6 feet 6 inches.
" beam, at ends, 2 feet 6 inches.
Thickness of plate, 3½ inches.
Mean thickness at centre, 7 inches.
Depth of core in centre, 11 inches.
" at ends, 7 inches.
Diameter of centre gudgeon bearing, 13½ inches.
" end gudgeon bearing, 6½ inches.
" quarter link bearing, 8½ inches.
Weight of beam on gudgeons, 44½ tons.
Number of boilers, 6.
Diameter of shell, 7 feet.
" tube, 4 feet.
Thickness of plates in shell, nine-sixteenths of an inch.
Thickness of plates in tube, ⅝ inch.
Length of boilers, 24 feet.
" fire-places in tube, 9 feet.
Aggregate area of grate surface, 216 superficial feet.
" heating surface, 8414 superficial feet.
Diameter of feed pump, 8 inches.
Length of stroke, 3 feet 6 inches.
Branch feed pipes, 4 inches bore.
Steam pipe, 14 inches bore.
Three safety valves to each boiler, loaded to 50 lbs. to the square inch.
Steam cut off at ⅜ the stroke, and discharged from the steam cylinder into a cylindrical heating tank, 7 feet diameter by 36 feet long.
Height of chimney, 120 feet.
Flue of a parallel form, 6 feet diameter.

Art. VI.—EXPERIENCE OF THE GOLD MINES OF CALIFORNIA.

UNION MINE, SUTTER, AMADOR COUNTY.

The Union Mine is situated in the town of Sutter, formerly known as Amador No. 2.

This mine was located in 1852, though but little work was done upon the lode during that year or the following. In 1854, an attempt was made to reach the lode by driving an adit from the west side of the hill to the length of about three hundred and fifty feet; at this point the vein was tapped and worked with variable success, but owing to the insecure manner of supporting the walls, and a rather reckless method of working the lode, it became abandoned for the time being, in order to settle up the affairs of the concern.

The work during this period was performed under lease and contract—a most disastrous course to pursue in gold mining in this country. The result of the operation was, that at the time the ninety-foot level on the south was completed, the property was in worse condition and of less value, so far as those works were concerned, than in the original state in which nature had placed it. In the latter part of 1854, the company had decided upon a systematic plan of working, and in the course of the past year have put that plan into execution.

The whole of the old works are abandoned for the present, and will not be used for the extraction of ores until levels are driven at the bottom of the present main shaft, when by stopping a winze between the upper and lower levels, and putting the main adit in repairs, good ventilation and an easy delivery of the ores to the surface will be made.

With this view and plan before them, the company commenced their first permanent operations in the early part of 1855, by driving a six-foot shaft in the lode to the depth of twenty-seven fathoms. The shaft is heavily timbered and planked from the top to the bottom, and is separated in the centre by a partition, on each side of which a pair of train rails are laid for the purpose of guiding the "riddle tubs" in which the ore is placed to be taken to the surface.

In all the mines in this portion of the State having inclined shafts, this system is now adopted. Each tub when loaded will bring up about four hundred pounds to a cargo.

At the bottom of the twenty-seven fathom shaft two levels have been commenced, and are driven north and south about thirty-five feet; at the distance of one hundred feet north of the main shaft, another shaft has been commenced and carried to the depth of nine fathoms.

At twelve fathoms from the surface, and connecting with the whim shaft, two galleries have been driven ninety feet each; the south gallery connects with the end of the old adit of three hundred and fifty feet, and may be used for the transportation of ores at a future day.

At the bottom of the main shaft the lode has a power of twelve feet, and possesses all the characteristics heretofore mentioned of the lodes of this part of the State, being more or less pyritous and streaked with graphite derived from the investing walls of the lode.

On the east side of the lode a rare feature is noticeable for this system of veins, and one wholly anomalous in this country. The ores are uniformly of a dark color, with a tint of blue in every mine thus far opened; but the east side of the lode of the *Union* carries a vein of pure white quartz, free from sulphurets or other admixtures, but containing pure metallic gold imbedded in coarse nuggets.

The mine employs fifteen men at an average rate of seventy-five dollars per month each, with board, and up to the present period has paid the entire expenses of labor and all the incidentals pertaining to the operation for the year, from the ores extracted during the opening of the mine.

RECAPITULATION OF WORKINGS.

	Fathoms.
1 shaft of	27
1 "	9
Total	36
	Feet.
2 galleries, 90 feet each	180
1 adit, 1854	350

Strike, north, 50° west; dip, 70° east. Power, 12 feet.

MIDIAN MINE, HERBERTVILLE, AMADOR COUNTY.

This mine was located in 1852, under the name of Lea & Johnson, and during 1853 a small amount of work was done upon it. In 1854 it passed into the hands of the present parties, holding it by purchase. The latter part of the year was spent in exploring the mine and the extraction of ore preparatory to reduction. During the past year the company have erected their reduction works and other necessary buildings, at an expense of $10,000; the power employed being water. During the past year the lower south level has been driven ninety feet, and a shaft sunk to the depth of seventeen fathoms. From the bottom of this shaft, which is used for hoisting the ore from the mine by a horse whim, a level has been driven fifty feet, and the distance between levels is sixty feet.

At this mine the sulphuret of molybdenum occurs associated with lead, and usually combined with the sulphuret of iron containing the gold.

The characters of the ores have changed materially at the depth of seventeen fathoms. From the surface down to the depth of twelve fathoms the pyritous minerals were much decomposed, and at times a considerable amount of red oxide of iron impregnated the ore. At the present time the ores comport in their dark blue color with those of the surrounding district, being highly charged with pyrites, which developes gold after calcination.

The shafts and levels on the east side of the hill are not used at present, on account of their distance from the reduction works, as a greater amount of mineral is obtainable from the workings in close proximity to the mill, the power of which latter is used to raise the ores from the mine, and a heavy item of expense is thus saved in teaming.

The failure of water to supply power during the past summer, prevented the reduction of ores beyond the period of four months,

which constituted the entire running of the mill for 1855; but this failure will probably be obviated the coming year by the introduction of a greater amount of water from other sources.

The walls of the lode are of graphic slate on one side, and an impure serpentine rock on the other; this latter is highly pyritous, and in the adjoining Herbertville Mine has proved highly auriferous. An examination of this rock will be found in the table of analysis and assay.

No statistics can be given of receipts and expenses, from the short period that the mine was reducing ore.

RECAPITULATION OF WORKINGS.

	Feet.
1 adit	60
1 level	90
1 "	50
2 levels, 1854	30
Whole amount of levels and adit	230

	Fathoms.
1 shaft	8
1 "	17
Whole amount shafts	25

Strike, north and south; dip, east 70°. Power, 9 feet.

BADGER MINE, SUTTER, AMADOR COUNTY.

The Badger Mine is situated about 1000 feet south of the Eureka, and is a continuation of the same lode. The reduction works belonging to the company are situated on the creek, half a mile west of the town.

This mine was opened in 1854. During that year an adit was driven to the length of three hundred and fifty feet, at an average cost of eight dollars per foot.

Between the latter part of that year and the month of December, 1855, a shaft was sunk to the depth of twenty-nine fathoms on the lode, at an expense of sixteen dollars per foot, including timbers and equipments for a whim. At the depth of twenty fathoms from the surface, a level has been carried north 20 feet, and south to the same distance, and at two and a half fathoms below the latter another level has been driven south of the main shaft to the same distance.

From the bottom of the twenty-ninth fathom shaft, a level has been driven south sixty feet and north fifty feet. A winze is carried from the middle level to the lower one, through the depth of five and a half fathoms from the end of the south level, and the ground intervening between the end of the middle south level is being removed in order to connect the two at the depth of sixty feet south of the main shaft.

From the latter part of 1854 up to date, the company have

erected their reduction works and other necessary buildings, at an expense of $12,000, and an additional expense of $2,500 in the construction of roads and kilns for the conveyance and calcination of their ores.

The character of the ores of this mine is precisely of the same character as those of the Eureka, next adjoining on the north.

The average running time of the mine during 1855, amounts to six months only, and a scanty supply of water part of the time.

The power of this lode has increased about thirty per cent. at the bottom of the shaft over the size of the anterop. The ores are heavily charged with arsenic, iron and molybdic sulphurets, in which free gold is disseminated.

The amount of assessments called on the opening of the mine and the erection of their works, was five hundred dollars per share, of five shares, and the balance of expenses for the period in which they have been in operation, has been derived entirely from the proceeds in the opening of the mine.

The mine has employed during the entire year twelve men, at an average of sixty-five dollars per month and board.

The following statistics will show the general expenses incurred in getting into operation:

Cost of Mill and Equipments	$12,000
" Main Adit,	2,800
" Roads and Kilns	2,500
" Teaming 1,080 tons of ore	1,080
" Shaft, Timbers and Equipments	2,820
" Fuel	192
Total general Expenses	$21,392

The average amount of ore reduced per month, with full head of water, is one hundred and eighty tons. The aggregate for the six months was 1,080 tons, yielding $35,000, or nearly $33 per ton.

The condition of the subterranean portion of the mine will be found from the following recapitulation:

RECAPITULATION.

	Feet.
1 Adit	350
1 Level, upper	20
1 " "	20
1 " middle	20
1 " lower	60
1 " "	50
Total levels	170
	Fathoms.
1 Main shaft	29
1 Winze	5½
Total shafts	34½

Strike, north and south; dip, east 70°. Power, four feet. Working, 26 fathoms below water-line.

HERBERTVILLE MINE, SUTTER, AMADOR COUNTY.

This mine has been alluded to in former reports, and is among the earliest that were opened in this State. Its operations have continued almost uninterrupted until during the past year. During this year but a small amount of ore has been reduced, in consequence of the failure of water to supply the motive power, the company having removed their engine on the erection of their large water-wheel in the latter part of 1854.

This has proved a serious inconvenience, not only to this company, but also the Midian, adjoining, both of which were dependent on the water of an adjoining canal to continue operations in reduction.

After the failure of the water the Director of the mine continued the sinking of the two whim-shafts, and the driving of the levels between them. Little, therefore, has been done other than to open the mine to a greater extent than formerly existed. This has been done at a heavy expense, and the small amount of ore reduced has nearly met the liabilities incurred.

The condition of the mine at the close of 1854 was as follows:

The south shaft had been sunk to the depth of twenty-three and a half fathoms, and the north shaft to sixteen fathoms, with levels, uniting the shafts which are distant from each other, one hundred and twenty feet, and extending beyond the shafts the length of two hundred and eighty feet, inclusive.

The work this past year consists in the sinking of the south shaft to the depth of thirty-six fathoms, and the north shaft to thirty fathoms. From the bottom of the thirty-six fathom shaft, levels have been driven each way and between shafts to the length of three hundred and twenty feet, the middle gallery to the length of one hundred and eighty feet, and the upper gallery two hundred and thirty feet; distance between levels sixty feet.

At this depth the ore maintains the same features as formerly, being highly pyritous.

RECAPITULATION.

	Fathoms.
1 North shaft	30
1 South "	36
Total shafts	66
	Feet.
Lower level	320
Middle "	180
Upper "	230
Total levels	730

Power 10 feet; dip, 68° E.; strike, N. 18° W.
Working, 28 fathoms below water line.

ROCKY BAR MINE, GRASS VALLEY, NEVADA COUNTY.

The Rocky Bar Mining Company was organized and went into operation as a gold-mining company in the early part of 1852. The grounds belonging to this company are situated on Massachusetts Hill and upon Gold Hill, in the town above mentioned.

Owing to the lateness of the season at which they commenced operations, and the sudden advent of the rains when but a small part of their adits and shafts was completed, they were obliged to relinquish the working on Massachusetts Hill for the balance of the season, or until the rains should cease, their works not being in condition to afford sufficient drainage.

The company, therefore, proceeded to purchase a group of claims on Gold Hill, from which they commenced the extraction of ore, and its reduction by the machinery which they had erected. The reduction continued until the month of June, at which time the company settled up their affairs; and it was found that, notwithstanding the inordinate high price of labor and necessaries, the company had met the outlays, which amounted to $47,000.

This was accomplished in the face of every obstacle which the times in which they operated presented; and those acquainted with those early days, are best capable of judging what men engaged in this branch of employment had, as a resultant, to encounter.

At the close of 1852 the condition of the workings on Massachusetts Hill were as follows:—

An adit had been driven two hundred feet, mostly through soft material, at an expense of ten dollars per foot, and another below it, of the same length, through hard trap rock, at an expense of $8,000.

In addition to the above, five shafts, averaging fifty-five feet in depth, were sunk, at an expense of $500. On Gold Hill, two shafts of fifty feet each, at the same cost as the above.

From the first part of 1853 up to the latter part of 1854, but little work was done upon the mine, from some dissatisfaction of the stockholders abroad. At this period the resumption of operations took place, under a new Director, who has proceeded to erect a system of working similar to that proposed in 1853, to free the mine from water, which was the only impediment to progress at the time the operations were relinquished. The present Director has erected a fourteen horse-power engine near the summit of the hill, and near the lode, and by the use of heavy pumps succeeded in freeing the mine and sinking a whim-shaft in connection, that now affords easy communication and ample facilities for all the underground operations that may be required.

The depth of the engine shaft is twenty fathoms, with a diam-

eter of eleven feet by six. It is well timbered and planked, and divided by partitions in such a manner that no impediments can interfere with the working, caused by ingress or egress, and the many other incidents that occur in operations of this character.

From the bottom of the shaft, an adit level has been driven eastward two hundred and ten feet, and another westward one hundred and forty feet, each being well timbered and ceiled, and the whole mechanical department is done in a strong and workmanlike manner.

The amount expended in dead work, in the re-opening of this mine, inclusive of the engine, has amounted to $25,000, and the enhancement in value to the property is more than double that sum. In the month of December little more than 1,000 tons of ore had been removed and reduced since the lode had been reached, and it is to be regretted that with the prospects before them, there appeared a disposition among some of the stockholders to withhold the necessary means that would place their property on a stable foundation and valuable source of profit for many years to come. There is required an outlay at the present time of a sum not less than $23,000, to put that mine in what would be considered a safe and good condition for future operations. The pump shaft should be carried to a depth of not less than thirty-six fathoms, in order to be able to remove the ore on the lode to advantage, and not subject themselves to the necessity of skinning where the lode is at any moment liable to become pinched, from its loose and decomposed character. There is more of irregularity in lodes where much decomposition of their mineral constituents has occurred, and more liability of nipping out in such cases, and should such an accident occur in any mine, it will frequently cost a greater sum to obtain it again than it would to have sunk to the firm rock, enclosing it in the first place at a greater depth.

Another improvement at this mine is most obviously required. This is the erection of their own reduction works: nearly one-third of the amount that would be required to erect a battery of sufficient capacity, and the necessary equipments, has been expended during the three months that they had been reducing ores, or up to the middle of December.

It is to be hoped that the proprietors of this mine may not be blind to their own interests to that extent as to allow so valuable a mine as they evidently possess, to remain a second-rate affair, when such fair prospects of large returns are manifest as in the lode which constitutes their property. But it will be impossible to make that mine what it ought to be, with so small an expenditure as that which has been applied to its opening.

No person in the slightest degree familiar with mining operations, can expect that the bare opening of the mine will in all

cases pay not only expenses, but a *dividend* on the investment; yet such seems to be the prevailing idea, even at this late day, with the experience of years before them to the contrary. And it certainly seems singular our friends abroad should expect such a thing, as they manifestly do under the circumstances.

Those who will examine this mine, and the work that has been performed upon it in its re-opening, cannot but conclude that the money has been judiciously expended; and the only thing to regret is, that a sufficient amount was not invested at once to do the work which is absolutely necessary.

The following statistics will show the present condition of this mine, its expenses and receipts:—

Number of men employed, thirty-four.	
20 Miners, at $4 per day	$1,920
6 Stokers, at $3 per day	432
2 Engineers, at 125 per month	250
2 Whim tenders, $100 per month	200
1 Blacksmith, $100 per month	100
1 Carpenter, $100 per month	100
2 Carmen, $80 per month	160
Incidentals	200
	$3,362
Aggregate amount of ore reduced in three months, 1,000 tons.	
Average value, $40 per ton	$40,000
Cost of reduction, at $6 per ton	6,000
Length of East Adit, 210 feet, cost $5 50 per foot	1,155
" West Adit, 140 feet " "	740
Depth of engine shaft, 20 fathoms.	
Aggregate expenses on mine for three months	$10,086
Aggregate of dead work, and value of engine since re-opening	25,000
Aggregate receipts	40,000
Whole amount Adit Levels, 350 feet.	
" Shafts, 20 fathoms.	

Working eighty feet below water line, pump discharges 260 gallons per minute.

BOSTON MINE, GRASS VALLEY, NEVADA COUNTY.

This mine is at present owned by a French company. No general history of the mine was obtained. The following are their statistics for 1854 and 1855 as nearly as they could be obtained:—

STATISTICS FOR 1854.

Number of men employed, nine.	
4 Miners, $5 per day	$480
2 Engineers, $160 per month	320
1 Battery tender	120
2½ Cords wood per day, $4 50	264
2 Stokers	160
Incidentals	280
	$1,624

Amount of ore reduced per day, 13 tons; average value $15.

Aggregate receipts for 9 months	$36,630
" expenses "	14,616
Balance in favor	$22,014

STATISTICS FOR 1855.

4 Miners	$384
2 Engineers	200
1 Battery tender	100
2½ Cords wood per day, $3 50	192
2 Stokers	160
Incidentals	200
	$1,236
Ore reduced per month, 338 tons; average value $15	$4,070
Aggregate receipts for 8 months	$32,560
" expenses "	9,888
Balance in favor	$22,672

The workings of this mine thus far have been mostly confined to the surface. No considerable depth has as yet been attained upon the lode. The affairs of the company appear to be managed in a prudent and economical manner. Their machinery is light, but effective for its weight.

OSBORN HILL MINE, GRASS VALLEY, NEVADA COUNTY.

The Osborn Hill Mine, and that of the Lawrence Hill, adjoining, and which is the property of one company, are situated about two miles east of the town. The reduction works of the company are situated on Wolf Creek, near the middle of the village. The mine was one of the earliest that was opened in the State, and has continued in active operation since the early part of 1853. As was the usual case with most of the veins that were worked during that period, this mine, like others, was worked without much system until the latter part of 1853, when the company adopted a much more systematic course than had been previously observed.

During 1853 the following work was done upon the lode of Osborn Hill:—An adit was driven to the intersection of the vein on one side, to the length of one hundred and ninety feet. At the contact the lode was found to have a dip of twenty-seven degrees. From the termination of the adit two levels were carried to the length of one hundred and twenty feet each, and one winze sunk to the depth of twenty-five feet. At the bottom of the four-fathom winze the lode had acquired an angle of forty-one degrees. Subsequent to this another adit was commenced fifty feet below the former, and carried to the length of one hundred and twenty-five feet, the last fifty feet of which was carried into the greenstone trap, which was very hard and compact.

From the very heavy expenses attending the driving in

this rock, and the great distance that it would be necessary to carry it, the enterprise was abandoned.

At this time there was considerable water in the mine, and as the season advanced it was judged most prudent to abandon this part of the lode for the present, and attack it at a more advantageous point, with the exception of the extraction of such ores as were available above the points of drainage. Accordingly in 1854 the lode was opened on Lawrence Hill, some six hundred feet to the north of the old workings. On this hill the company put in what may be considered their first permanent workings.

On this hill they commenced and carried down a large whim shaft to the depth of 19 fathoms. From the bottom of this shaft a level was carried north about one hundred and sixty feet, and south one hundred and thirty feet. These two levels laid out a heavy bed of good ore two hundred and ninety feet in length.

The advantage of this deep whim shaft will become apparent when it is stated, that it cuts the lode fourteen fathoms below the lowest point worked in the old operations of 1853, and for a length of six hundred feet will drain that part of the mine, thus affording an opportunity to extract that mass of ore at any future day. During 1855 the works have been continued in this part of the mine. The north level is carried to the length of two hundred feet, and the south level to one hundred and sixty feet. On the north level two winzes have been sunk to the depth of five fathoms, and on the south level one winze to the same depth. A breast of fifty feet has been carried down to the depth of six fathoms below the winzes. The lode is now opened and in condition for drainage to the depth of twenty fathoms below the old workings, and with which the vein is continuous, and will keep the mine clear of water to the depth of thirty-nine fathoms for the length of eight hundred feet south. The engine now discharges the water from the main shaft, and with its lateral attachments, to the depth of one hundred and forty-two feet.

The cost of sinking the engine shaft was thirty-three dollars per foot, and in fact the best investment ever made upon the mine. They are now working sixty-eight feet below the water line on this part of the lode.

The following statistics will show the comparative expenses of working during 1854 and 1855:—

STATISTICS FOR 1854.

20 Miners, $80 per month	$1,600
2 Engineers, $112½ per month	225
2 Battery tenders	150
5 Stokers	250
2 Shaft tenders	200
1 Blacksmith	75
1 Carpenter	75
2½ Cords wood per day, at $4 50	240
Teaming	900
Total	$3,715

Dead work on engine shaft at $33 per foot	$3,828
Average amount ore reduced per month, tons	520
Average yield per ton	29
Average yield per month	14,880
Aggregate yield for 7 months	$104,160
Aggregate expenses for 12 months	48,408
Balance in favor	$55,752

STATISTICS FOR 1855.

18 Miners at $75 per month	$1,350
2 Engineers at mill	200
2 " at mine	160
2 Battery tenders	120
2 Shaft "	120
3 Stokers	150
1 Carpenter	65
1 Blacksmith	65
2½ Cords wood, at $3	156
Teaming, $20 per day	480
Total	$2,866
Engine and dead work for mine	$10,000
Amount ore reduced per month, tons	520
Average value, per ton	25
Aggregate receipts for 6 months	$78,000
Aggregate expenses for 12 months	44,828
Balance in favor	$33,172

RECAPITULATION OF WORKINGS.

For 1853.

	Feet.
1 Adit	190
1 "	125
Total adits	215
2 Levels, 120 feet each	240

1 Winze, 5 fathoms; 6 shafts, 240 feet.

For 1854.

	Fathoms.
1 Whim shaft	19
	Feet.
1 Level, north	160
" south	130
Total Levels	290

For 1855.

	Feet.
1 Level, north	40
" south	30
Total Levels	70
	Fathoms.
3 Winzes, 5 fathoms each	15
1 Breast	6

It should be borne in mind that, during those periods in which improvements are going on, the companies are obliged to retain their men at ruling rates, though no ores are reduced in the interim. This frequently subjects them to heavy expenses, as in the case before us, and also with most of the other mines in the State who date their opening in 1852 and 1853.

The ores of this mine still retain their peculiar characteristics as in the preceding year; the arsenical sulphurets predominating.

ART. III.—ON THE COMPOUNDS OF CARBON AND IRON, AND THEIR INFLUENCE ON THE PRODUCTION OF PIG IRON.* By A. GURLT.

THE compounds of iron with carbon, which are of such great importance in the commercial production of iron, inasmuch as, owing to the very difficult fusibility of pure iron, it would be impossible to obtain the metal without them on the large scale, belong to that class of chemical compounds in which several atoms of the electro-positive constituents are united to one atom of the electro-negative body; they may therefore be considered as subcarburets analogous to certain combinations of iron with sulphur. The tetracarburet, as it occurs most frequently in the white crystalline pig iron (*spiegeleisen*) or specular iron, and the varieties related to it, has long been familiar to us from the researches of Karsten. In it the iron is completely saturated with carbon, and cannot be made to take up more by prolonged fusion with charcoal. In its pure state it consists of 94·88 parts of iron, and 5·12 carbon, corresponding to the formula $Fe^4 C$. In this compound the whole of the carbon is chemically combined with the iron; it is rarely met with however in a state of absolute purity. In general it contains, in addition to iron and carbon, a variable amount of manganese, occasionally amounting to 6 per cent. As it is most frequently obtained from ore containing much manganese, on the other hand it usually contains a rather larger amount of carbon than the pure tetracarburet. As, however, the manganese replacing the iron in this compound possesses a lower atomic weight than the iron, a certain weight of manganese will combine with a larger amount of carbon than an equal weight of iron; and the amount of carbon which may exist in it without exceeding the maximum for the pure tetracarburet, will depend on the proportion of manganese existing in the specular cast iron.

The pure tetracarburet of iron possesses a specific gravity of 7·65 to 7·66, a silver-white color, great hardness, is very brittle, and is commonly crystalline, although its form is of very difficult determination. According to Karsten and Hausmann, it does

* From the Lond. Chem. Gaz., No. 327.

not belong to the cubic system, but the crystals consist of oblique prisms, among which an oblique terminal plane can occasionally be discovered, so that it would rather appear to belong to the oblique system. The crystals are most frequently tabular, and then appear to be merely rudimentary, intersecting one another at indefinite angles. Mitscherlich observed an angle of 120°; Rammelsberg one of 116°, also of 130° to 131°; and the author found, in a specimen from Silesia, angles belonging to oblique prisms measuring respectively 128° to 129°, and 52° to 53°; still the primitive form cannot with certainty be determined from these measurements. The fracture is highly radiate crystalline, and frequently exhibits cavities between the crystalline laminæ. The specular iron is the most fusible of all the combinations of iron with carbon. Its melting point is about 1600° C., and it becomes solid without previously assuming a thick pasty condition.

The octocarburet of iron, $Fe^8 C$, does not appear to have been recognised hitherto, although it not frequently occurs crystallized in gray pig iron, never, however, in white pig iron. It is distinguished from the tetracarburet not only by its chemical composition, but also very distinctly by its crystalline form and its other physical properties. The crystals which were observed by Karsten, but not further examined, belong to the regular or cubic system, and almost always appear in the form of confused octohedral groups, with the planes not well defined, but the angles occasionally sharp.

The author examined a piece of such crystallized cast iron from the works of Gleiwitz, in Upper Silesia, found in the core of a cast iron gun. It presented the following composition:—

Carbon	2·46
Graphite	2·84
Silicium	0·26
Iron	94·20
Sulphur, Phosphorus	traces.
	99·76

The absolutely pure octocarburet of iron should contain by calculation 2·63 carbon, and 97·37 iron. In the above specimen, however, a small portion of the chemically-combined carbon was replaced, as has often been observed to be the case, by a small portion of silicium, while the graphite must be considered as mechanically mixed with the iron.

Hence the crystals examined may be considered as a mixture of a carburet of iron and siliciuret of iron, consisting of—

91·548 per cent.	Fe + 2·46 C =	94·008 Fe^8C
2·660 per cent.	Fe + 0·26 Si =	2·920 Fe^8Si
	Graphite =	2·840
		99·768

§ In the former constituent the carbon is to the iron as 1 : 87·3, and in the latter the silicium is in the proportion of 1 : 10·0, closely agreeing with the calculated composition ; and as the octocarburet so largely preponderates in this compound, one is fully justified in describing it as such.

The physical properties of the octocarburet are very different from those of the tetracarburet or specular iron ; the specific gravity is =7·15, the color iron-gray, the hardness and brittleness much inferior ; the former is to a certain degree malleable, as it retains the impression of the hammer when struck, while the latter flies to pieces ; the fusibility of the octocarburet is less than that of the specular iron. It appears to occur frequently, its production being invariably connected with that of gray iron. The crystals are commonly found in the form of pyramids, extending to as much as two lines in thickness, often beautifully iridescent on the surfaces, in the cavities of large castings such as rolls and pieces of ordnance. These crystals, however, are not to be confounded with those regular crystals of soft malleable iron, which are sometimes produced during the oxidizing melting processes, such as refining and puddling ; these latter contain no carbon, and are so free from foreign matters that they may be considered as nearly chemically pure iron.

The author believes that similar crystals to those of the octocarburet described above, have been found at the blast-furnaces at the Konigshutte in Upper Silesia Ilsenberg in the Hartz, Marienhutte near Zwickan, &c., which have most probably a similar composition ; but he has had no opportunity of investigating hem more accurately.

As the existence of two distinct subcarburets of iron may be taken as a fact, it will become important to inquire what influence they exert on the production of pig iron. The several varieties of cast iron which are technically received at the iron works, may be brought into two groups, which differ from each other chiefly in their physical qualities. The first group will include all the varieties of white cast iron, which exhibit a silver-white color on the fracture, and a more or less radiate crystalline structure, together with a great degree of hardness and brittleness, and also a relatively high specific gravity =7·2 to 7·6 ; and in them no graphite is ever to be distinguished by the naked eye. This group must, however, be subdivided into two subdivisions, determined by their chemical compositiou, the first of which will include all those varieties of white cast iron, containing a large amount of chemically-combined carbon, amounting to from 4 to 5 per cent., such as specular iron and varieties allied to it. The second subdivision includes all the descriptions of white cast iron containing smaller quantities of carbon, included in the technical term " white cast iron," but which generally contain considerable quantities of sulphur and phosphorus. In the second larger

group are included all the varieties of gray cast iron in which graphite can be distinguished by the naked eye, possessing a specific gravity of 7 to 7·2, a granular structure, gray color, and greater toughness, but a less degree of hardness than the varieties of the first group. The gray cast iron must also be separated into two subdivisions, of which the mottled cast iron is the richer in carbon; the other is the gray pig iron proper, containing frequently a considerable amount of silicium. The essential constituents of all pig iron are but two—viz., iron and carbon: the latter in its modifications of graphite chemically-combined carbon; all the other substances occurring in it may be considered as impurities. Among the electro-positive bodies, manganese is almost always present in cast iron, and at times zinc and copper, which replace an equivalent proportion of the iron; while the electro-negative substances, as sulphur, phosphorus, and silicium, replace the carbon combined with the iron. In proportion to the quantities in which these impurities are present, is their effect in modifying the physical qualities of the metal, such as its toughness and specific gravity.

Hitherto these impurities in the cast iron, which seldom amount to more than 4 per cent., have been neglected in considering its chemical constitution, although Karsten has directed attention to the influence which the electro-negative impurities exercise on the compounds of iron and carbon on fusion. As his experiments throw so much light on the formation of the carburets of iron, it may not be considered out of place here briefly to describe his results.

Karsten found that when cast iron containing the largest amount of chemically-combined carbon, Fe^4 C, was melted with sulphur in a covered clay crucible, there was found, on cooling, on the surface, sulphuret of iron, under this a layer of separated carbon in the form of graphite, and under this again a mass of cast iron with the maximum of carbon, proving in a most striking manner that the chemically-combined carbon is separated at the temperature of fusion in the form of graphite from its combination with the iron, and on the other hand, that carbon was incapable of decomposing the sulphuret of iron. When this experiment was varied by pouring melted gray cast iron containing only 3·93 per cent. of carbon (of which 3·311 was graphite, and 0.625 chemically combined) on to sulphur, whose quantity was not sufficient to convert all the iron into sulphuret, or when gray cast iron was melted with sulphur, there was found under the stratum of sulphuret of iron white cast iron with maximum of carbon, the whole of which was chemically combined with the iron; and when the amount of sulphur was slightly increased, graphite was also separated. From which it is clearly proved, that the carbon in the melted cast iron, on the addition of sulphur, is continually concentrating in that part of the iron not combined with the sul-

phur until the point of saturation is reached, when graphite begins to be separated.

In the strict analogy to that of sulphur is the action of phosphorus, and also of silicium, which form phosphuret and siliciuret of iron, while the carbon is concentrated in the remaining iron, or the excess separates in the form of graphite. This behavior of the electro-negative constituents of the cast iron will explain the occasional occurrence of graphite in white cast iron, and even in well characterized specular iron; and this appearance is usually to be attributed to the presence of a little silicium, which combines with the iron at a very high temperature, and decomposes a portion of the carburet of iron. In fact, a small portion of silicium is always found in the analyses of white cast iron with graphite. The uncombined carbon, however, exists in such a small proportion in white cast iron as not to be seen by the eye, but is only discovered in its chemical analyses. From the action of sulphur, phosphorus, and silicium, on the carburets of iron above described, it follows that they must be considered as chemically-combined with the iron, replacing the carbon chemically-combined with it.

It is well known that the absolute quantities of carbon are different in white and gray pig iron, even when they are prepared from the same ores and under similar circumstances, the proportion of carbon being always less in the gray than in the white cast iron. The only exceptions to this rule are the varieties of iron produced by remelting in a reverberatory furnace, by which white cast iron can be converted into gray, and *vice versa*. In such irons the altered product usually contains the same amount of carbon as the material employed originally contained, one portion of the carbon merely passing from one modification to the other—viz., from the state of chemically-combined carbon to that of graphite when the product is gray, or from graphite to chemically-combined carbon when the product is white. In gray pig iron a large proportion of its carbon is not in a state of chemical combination, that is to say, it is in the form of graphite; with white cast iron this is very rarely the case, and those rare cases existing in very minute degree. It was mentioned above, that the conversion of the chemically-combined carbon into graphite was effected by the decomposition of the tetracarburet by sulphur, silicium, and phosphorus; there is, however, another method of separating the carbon from the tetracarburet in the form of graphite, that is, by heat.

It is known from experience that white pig iron may be converted into gray, causing a separation of carbon in the form of graphite, by exposing it to a degree of heat much above that required to effect its fusion; specular iron may even be converted into gray cast iron in this way; now this can only take place when its composition, as tetracarburet is destroyed, and it passes

to some lower degree of carburation, setting free carbon as graphite. This high degree of temperature therefore effects this decomposition of the tetracarburet, and slow cooling favors the separation in large flakes; but even when this cooling is rapidly effected, the pig iron contains an equal quantity of graphite, which may be determined by chemical analyses, but which is difficult to be detected by the eye, from its being disseminated in minute particles throughout the mass, and for this reason a gray cast iron rapidly cooled appears to the eye like white cast iron. The degree of heat above that of its fusing point necessary to convert completely the specular iron into gray iron, has not been ascertained with accuracy, owing to the difficulty of measuring such high degrees of temperature; so much experience has taught, however, that in order to obtain gray pig iron, the temperature of the furnace must range far above the fusing point of specular iron.

As the absolute, as well as the relative quantity of carbon in the several varieties of cast iron is different, it may be asked whether it exists in any definite proportion to the iron not combined with any other electro-negative substance. With regard to white cast iron, the view is held that the combined carbon is united to the whole mass of the iron, though not in definite proportions. With regard to gray cast iron, however, it has been assumed that only a proportionally small quantity of the iron was chemically united to the carbon, forming a carburet, which was held in solution as it were in the remainder of the iron which existed in the state of malleable iron; still this soft iron was not to be considered altogether free from carbon, but to contain a minute quantity of carbon combined with it in the same manner as in bar iron. Against this view, which even yet has many supporters, it may be urged, that although it certainly is possible for carburetted iron to dissolve soft iron, as in the natural steel refinery and in the fabrication of cast steel; still the product is steel and not pig iron, and that its production depends upon processes essentially differing in principle from those upon which the production of pig iron depends. Steel is produced under all circumstances, directly or indirectly, by an oxidizing melting process, in which the separation of the sulphur, phosphorus, silicium, and also both the chemically-combined and free carbon, is so far affected by the oxygen of the air, that only a portion of the iron remains in the state of carburet, while the whole remaining mass is in the condition of soft iron. In the production of pig iron exactly the reverse occurs; the melting process is a reducing one, in which the iron is exposed to the action of a large excess of carbon and carburetted gases in the most intimate contact. If it be now considered that the affinity of iron for carbon at high temperatures is very powerful, as the process of cementation sufficiently proves, it must necessarily be admitted that if by any chance soft malcable iron should be present in gray pig iron, it must necessarily

unite with carbon to pass again into a combination of iron and carbon; for it is impossible it could exist uncombined under the influence of the reducing gases of the furnace in the presence of the graphite, always intimately mixed with the gray iron.

While, therefore, we are forced to admit that the iron never exists in pig iron in the condition of malleable iron, but must always be, throughout its whole mass, in a state of combination with the electro-negative constituents, as carbon, sulphur, phosphorus, and silicium, the hypothesis of the existence of a polycarburet, which Karsten and Berthier assumed in order to account for the peculiar properties of crude iron, and which, according to Berthier, would contain 18·3 per cent. of carbon, must fall to the ground, because such a polycarburet could only exist simultaneously with soft iron. But independently of this reason, the hypothesis of a polycarburet is upset by the simple fact, that iron, by taking up rather less than 6 per cent. of carbon, is already saturated; and therefore its combination with 18 per cent. is an impossibility. We may therefore consider it as proved, that the chemically-combined carbon is chemically united to the whole mass of the iron not already combined with the other electro-negative substances, and that the graphite is the only mechanical admixture in pig iron. If we are no longer permitted to doubt the existence in every description of pig iron of certain definite carburets, it becomes important to know the combining proportions of the carburets from which these different varieties of cast iron have originated.

In the specular iron, the pig iron containing the largest amount of carbon, these proportions are known: they are those of the tetracarburet, which contains one atom of carbon to four of iron. With regard to the gray cast iron, it is certainly remarkable that the crystalline octocarburet described above should occur so frequently and exclusively in it; and it becomes important to seek herein a close relation between the gray cast iron and the octocarburet. In fact the following reasons appear to warrant the conclusion that the carburet of iron existing in gray cast iron is the octocarburet:—1st, the physical properties, as color, hardness, toughness, specific gravity, malleability, agree in both; 2d, the octocarburet occurs very frequently in gray cast iron, and separates in the crystalline form from gray cast iron only; 3d, the tetracarburet (specular iron), at a temperature much above its melting point, becomes converted completely into gray cast iron, in which the proportion of chemically-combined carbon represents that of the octocarburet.

If, therefore, we are authorized in considering the carburet of gray cast iron as identical with the octocarburet, and we bear in mind that gray cast iron is produced by the decomposition of Fe^4C at an elevated temperature, it becomes exceedingly probable that gray cast iron is always formed from the tetracarburet. If

now the decomposition of the Fe^4C should not be complete, owing to the necessary temperature not being sufficiently protracted, it is clear that a cast iron will be produced composed of a mixture of tetra and octocarburet, such as the mottled cast iron. Mixtures of octo and tetracarburets are found, however, in other cast irons, differing much from the above, and which contain a large amount of white cast iron poor in carbon. This white pig iron, which contains much sulphur and phosphorus, is always produced at a proportionately lower temperature and with an overcharged furnace. The small quantity of fuel consumed in the reduction of the iron produces this effect: the reduced iron does not remain long enough in contact with the fuel, and the supply of carbonizing gases being deficient, it does not become thoroughly saturated with carbon, and a portion of the iron remains as octocarburet, and is mixed with that portion which has been saturated with carbon to form the tetracarburet.

(To be Continued.)

Art. IV.—THE READING RAILROAD—ITS PROGRESS AND RESULTS.*

Elected as a manager in 1843, I soon became greatly interested in a work that I then conceived had such a brilliant future. A careful investigation soon inspired me with such confidence, that on the refusal of the then President to continue to discharge the duties of his office, I did not *long* hesitate to accept the proffered position of President. Permit me briefly to refer to the position of the Company, and the efficiency of its works at that period. It was embarrassed by a floating debt of more than $1,500,000, some portion of which was in the shape of judgments; for I well remember that the day after my election, the passenger, locomotive, and cars were seized by the sheriff while stopping at Reading. The Company was without credit, except with a few capitalists, chiefly non-residents, whose careful investigation had resulted in much confidence in the eventual success of the work.

The capital and debt then stood thus:—

Capital Stock	$2,010,000 00
Bonded debt, maturing from 1844 to 1860	3,191,050 00
Bonds and mortgages	125,750 00
Floating debt	1,818,612 06
	$7,145,412 06

With $26,119 55 on hand.

This was the financial position of the Company.

* Speech of John Tucker.

The capacity for business consisted in a single track from Mt. Carbon to the junction with the State railroad at Peter's Island, with a branch road to Richmond. No connection then existed with the roads terminating with Port Carbon, which last year transported 1,170,000 tons, of which 740,114 tons passed over the Reading road.

The Company then owned 1592 coal cars, 39 locomotives (30 only of which were adapted to the transportation of coal), and five wharves at Richmond. In 1843 the business of the Company was as follows:—

Coal transported, tons	218,711
Merchandise	17,534
The gross receipts	$394,318

I have thus briefly stated, gentlemen, the position of the Company at the time I was elected President.

To have deputed to me, then so young a man, the responsibility of relieving the Company from its great embarrassments, and, in addition, to meet the rapidly increasing wants of the public, which I ever regarded as the implied contract of the charter, you will admit was quite sufficient to stagger men of much greater ability and influence, than I ever presumed to possess. Still, with more courage perhaps than discretion, I resolved to undertake both duties, with a determination that success or the utter prostration of both my physical and mental abilities should be the termination. These objects constituted my Pole star, during my official connection with the Company. Any personal sacrifice was a secondary consideration.

But, gentlemen, under what circumstances were these important duties assumed? Well do I remember that shortly after my election as President, I happened to be at a "Wistar party," when I was soon informed that a gentleman (now deceased) occupying an exalted position, was making some remarks in an adjoining room, about the Reading Railroad. Curious to hear his views, I soon joined the little coterie who were listening to him. On my being observed by the speaker, he remarked after the interchange of the usual salutations, that he was not aware that I was present, for if so, he would have refrained from indulging in such free comments about the Company with which I was connected. To this, I replied, that I had not heard them, and that I should be pleased to learn his opinions. To be brief, he observed that the passenger and merchandise business of the Schuylkill Valley (remember this was in 1844) could not support a railroad costing $10,000,000. As for a pretence that it could compete with a water communication in the transportation of such a heavy and bulky article as coal—it was an absurdity, and as a consequence the bonds and stock of the Company were worthless. Gentlemen, you must well remember that this was the general

feeling in 1844. I was, however, entirely confident that this judgment was not well founded. I, therefore, modestly, but with great confidence in my position, proposed to look into the matter a little, and asked how many cords of wood would be required to bring from Mount Carbon to Philadelphia, 250 tons of coal, and take back the empty cars, and what would be the cost of the fuel? to which he replied, that that was a question of detail, with which he of course was not familiar. I then inquired what was the cost of repairs of a locomotive on any of the New England or Old England Roads per mile run, or per ton transported, or any way which he chose to take it? to which the same answer was given —"I do not know." I will not detain you by repeating each question I proposed, but in my various queries, I enumerated all the items of expense in transporting coal by a railroad, to all of which he had but the one answer—"I do not know." I then quietly observed that the total cost was of course made up of these various detailed items, and as he was entirely ignorant of these, he must, as a necessity, be equally ignorant of the aggregate cost. I then expressed my surprise that a gentleman occupying so prominent a position should have expressed such a confident opinion about the value of a property costing $10,000,000, and the next moment have to admit that he knew *nothing at all about it.* I added, that if I wished an opinion upon a point of law, that I would call on him, as that was his profession, and he would have a basis for his opinion; but if I wanted to know the value of a railroad, I should certainly apply to some one who had made the cost of transportation as much of a study as he had that of the law. Feeling my advantage, I perhaps rather provokingly observed—now let us see what you know about the cost of transporting coal on a canal. I then asked how many bushels of oats would be required for two mules to transport a boat with sixty tons of coal from Pottsville to Philadelphia, and take back the empty boat, to which he replied—"Confound your questions; I have heard enough of them." Subsequently, we had many pleasant allusions to this discussion.

On another occasion I had necessity to use similar arguments. A committee of gentlemen, connected and familiar with railroads, were appointed to investigate the expense of transporting coal on the railroad, and generally the prospective profits of the Company. They evidently commenced their investigation with an impression that it was impossible that the work could be performed at the cost I had stated. They had not thought much, however, about the favorable grades. But when I had discussed all the items of expense, as given in Statement II. of the annual reports, I found I was getting myself into a difficulty. These gentlemen concluded that the cost was too high, and that they could do it for less! I was very willing to let it go so, although I did not exactly believe it. It was interviews like these, with sharp interchange of opinions, that maintained my confidence.

But there was another feature of no less importance, and that was your constant clamor for more cars. You will recollect how you used to bother me for increased means for transporting your coal. At times it seemed as though you never could be satisfied with any arrangement for the distribution of cars, which I could make, and when I offered to let you have your own way about it, you will remember, that you could not do much better for yourselves than I had done for you, as you always came back to me to adjust the difficulty. But, gentlemen, you little knew how much you frequently disturbed me. Many a time have I had to devote hours of the morning to convince you that you were receiving your fair proportion, when all the while I was intensely anxious to know how the bank account was to be made good at three o'clock! But I always found you most reasonable; for however much excited when you came to the office, I was always able to satisfy you that you had or would receive full justice, and you went away in good humor. You little knew, however, the anxious hours which I passed to obtain the additional facilities which both you and the true interests of the Company required. To accomplish this, for several years, midnight usually found me at my desk, engaged in the effort to inspire the necessary confidence to enable the Company to command the means to meet the requirements of yourselves and the public, which for ten years averaged about $1,000,000 per annum. These are the facts. How the duty was performed, I leave to others to decide.

From 1844 (the date of my election) to 1850, all the engagements of the Company were met without dishonor. But in January, 1850, about $2,500,000 of bonds fell due. The knowledge of this fact had greatly crippled the otherwise improving credit of the Company. A few of these bond-holders commenced suit. A successful issue with them would have encouraged others. The bonds were freely offered at less than fifty per cent. Under such circumstances, to attract new friends with the requisite capital on reasonable terms was hopeless. Old friends were tired, even if their means were not exhausted, by such repeated application for aid. Creditors were frightened, and stockholders confounded with the apparent difficulties. In the emergency resort was had to the Legislature by application through an ingeniously prepared act for relief, by extending under proper regulations and conditions, the time of payment for twenty years. Conscious of rectitude of purpose, with a clear knowledge that such a measure would best promote the interest of all interested, I bent the most unceasing efforts to attain the required relief, which, as you must remember, resulted in remarkable success. Whatever others may think of the propriety of the act, I well know that no law was ever more beneficial to all the parties in interest. With this happy legislation the financial difficulties of the Reading Railroad Company terminated.

What is now the positio nof the Company? Its credit is perfectly established on a firm basis. The President sits in his comfortable office, without any cause for the least anxiety about the finances. If he requires money he has but to intimate it and tenders are made on the simple security of the Company's note for amounts vastly beyond the requirements—and he has merely to accept the best bids. How changed in a few years! He has also at command 141 locomotives, about 5000 cars, 18 wharves at Richmond, with all other requisite facilities. He thus can meet all your wants, and those of the public generally. He can continue to do so, as his command of capital seems almost unlimited, and he and his Board of Managers, with the assent of the stockholders, have merely to decide on its judicious application. And with equal, if not greater satisfaction, large dividends can be made to the proprietors. Mark the change—

	Coal tonnage.	Mdse tonnage.	Through Pass.
In 1843 .	. 218,711	17,534	26,424
1855 .	. 2,213,292	154,384	111,822

In 1843, Capital and Debt .	. $7,145,412 00
1855 Do. .	. 19,004,180 00

	Gross Receipts.	Net Income.
In 1843 . .	. $394,318	$179,395
1855 . .	. 4,321,793	2,593,915

These figures, gentlemen, demonstrate that we Pennsylvanians have a railroad, which for its length, in business and gross receipts, exceeds that of any railroad in the world. I think I may also assume that in usefulness, transporting, as it does, an article of necessity, it stands at the head of railroads. Some of the details connected with its immense business, would be, perhaps, interesting. The quantity of water evaporated daily, when in full operation, is 520,000 gallons. Hence you may think, perhaps, that an identity of interest with the Schuylkill Navigation Company is also essential. But that involves a point, if ever the occasion requires, which I must leave to others to discuss.

The number of wheels required for ordinary repairs was, last year, 6,953, with axles, &c., in proportion.

The number of men employed is frequently more than 2,700.

The tonnage transported, even for the ordinary repairs, 247,478 (in 1855) exceeds the total tonnage of most of the railroads in the country.

In 1844 the railway from Mount Carbon to Port Carbon was finished. The weak and crooked Mill Creek Railroads, with a gauge of 3 feet 8 inches, were rebuilt, and thus the cars of the Company could run direct to every mine. It is true that by this change many of your narrow cars were thrown out of use, but the Company supplied you with their own, and this induced a similar change on the part of the Canal Company. Locomotives were soon substituted throughout the region for your expensive and

troublesome horse and mule power. Thus you were relieved from a large investment of capital for the transportation of your coal to the principal depots. Wharves were also erected for you at Richmond, which again caused a similar policy by the Canal Company. Thus has your business been greatly simplified; and this has been the general policy of the Company, not only at its termini, but at all the important stations on the line of the road. The mutual advantages of this liberal policy are best demonstrated by the great growth of the business, and rapidly increasing population throughout the valley of the Schuylkill.

. . . . . .

And now, gentlemen, having enlarged at great length on subjects connected with the railroad, for which you must pardon me, as this is the first time that I have ever alluded to it, we will next consider the great and important traffic in which you are engaged, viz., the production of coal. It is the basis of prosperity, not only to the great work to which I have referred, but also to the Schuylkill Navigation Company, whose history would be equally interesting.

Gentlemen, do you properly appreciate the importance of the traffic in which you are engaged? Coal, by its low cost, its easy and cheap transit, its economy in use, is not now only essential to the domestic comforts of both rich and poor, but must be for ever connected with the steam engine, and is thus inseparable from the commerce and manufactures of our country.

Have you ever reflected seriously upon the vast importance to the commercial and financial position of this city? Are you aware that your coal tonnage greatly exceeds that of all the other marine interests of this port combined?

The following facts will demonstrate that it is so. The arrivals of foreign and coastwise vessels at the port of Philadelphia, including Richmond, in the year 1855, were:—

Ships	213
Barques	262
Brigs	718
Schooners	6398
Sloops	3169
Steamers	945
Masted vessels	11,700
Boats and barges chiefly in the coal trade	18,523
Total	30,823

Of these, there were employed in your business at Richmond:

Ships	22
Barques	57
Brigs	446
Schooners	5267
Sloops	481
Steamers	80
Masted vessels at Richmond	6353

The exact number of boats and barges loaded with coal I cannot now ascertain, but it must have been a very large proportion.

These facts are better than any comments to show the importance of your trade to the commerce of this city. We may not hesitate to compare it with that of New York.

It has frequently been stated that the tonnage of our port of Richmond exceeds that of the total foreign tonnage of the port of New York. But the coastwise business of our Coal Depot compares most favorably with that of New York. In 1855 the number of coastwise arrivals at that port was 6302. Of these a very large number were laden with your coal.

Let us next consider the influence of your trade upon the financial position of our city. Well do I remember that upon being elected a Director of one of our oldest Banks in 1839 (the first year of my residence in the State), with how much interest the Directors, at their semi-weekly meetings, inquired as to the indebtedness of the Bank to New York and New England, from whence there was a constant drain of specie. Thus, they controlled the banking movements of our city. Schuylkill County produced in that year 442,600 tons of coal. Its value at tide water was about $200,000, of which not one-half was exported. In 1855, Schuylkill County sent to market 3,318,555 tons; of this, a quantity sufficient to produce more than ten millions of dollars was exported to our neighboring States. Where, let me ask, would Philadelphia stand without this great regulator in her financial position? Why, gentlemen, the total amount of specie held by our city banks seldom equals $4,000,000. Stop your exports of coal for half a year, and what would be the effect even on this city? I will not pretend to demonstrate the results. We may, perhaps, imagine them by comparison. We well know that when our neighboring city of New York becomes indebted to foreigners to an extent beyond the semi-monthly receipts of gold from California, an immoderate curtailment by the banks follows, and consequently an immoderate reduction in the value of property. We also know that when our banks become debtors to those elsewhere, and coin is largely demanded in payment, a similar policy must ensue. But it is no part of my design to allude to questions of finance. We know, however, that you Schuylkill County Operators furnish for export ten millions of dollars worth of coal, which must of necessity be of great importance in maintaining the financial equilibrium of our city. Is the importance of your position and business duly appreciated? When you apply to our banks for the usual facilities extended to other general business interests, do you receive your equal share of their accommodations? Do the officers even recognise the importance of your traffic? Do they realize that you must first invest a very large capital in improvements at your mines, must then pay cash for the whole value of your product at tide water,

and then sell all on credit? It is well known that the importing business is conducted generally by a system of credits. The grocer, the dry goods jobber, and most other merchants, buy as well as sell on credit. Is this difference properly appreciated by our moneyed institutions? Again, I ask, do you receive your proportion of their facilities according to the nature and importance of your business? No, gentlemen—you and I know that it is not so—you are compelled to go to other cities for two-thirds of your banking facilities. Why are you thus dependent? I purpose soon to avail myself of an occasion even more private, to endeavor to solve this question. I shall contend that you have the power and the remedy in your own hands. You, who produce an article that is not subject to the caprices of fashion, but one of stern necessity, for which there is no substitute at the reasonable price at which you will ever offer your coal, should be enabled to dictate terms that should soon render your business more independent than any other I know. Silks, wines, sugar, coffee, tea, &c., may be dispensed with, but not so with coal. It was not my intention, however, to allude on this occasion to the difficulties you have thus encountered, or the plan or mode of removing them. I repeat, however, that this great interest has not been sufficiently cherished and fostered.

Grant me your indulgence while I briefly call your attention to the coal trade of the world. From the best data attainable, the area of the coal measures of the United States is 133,732 square miles, of which Pennsylvania has 15,437; British Provinces, 18,000 square miles; Great Britain and Ireland, 11,860; Spain, 3,408; France, 1,719; Belgium, 518.

The German States also contain and produce a considerable quantity of coal. This mineral is also found in Russia, Asia, Africa, South America, Australia, New Zealand, and in some other Islands. But few of these deposits are worked, however, except in Europe and North America.

Here let us glance at the progress in the consumption of this fuel. In Great Britain, in 1845, it was 30,000,000 of tons. I have not been able to refer to tables showing the annual increase, but in 1855 it was 64,453,000 tons.

As nearly as can be computed, it was in 1855, in—

Great Britain	64,453,000
British Provinces	302,000
United States	12,335,000
Belgium	5,500,000
France	4,560,000
Prussia	3,850,000
Spain	600,000
Allow for China, Russia, and elsewhere	3,500,000
Present production of coal in the world, per annum	95,000,000

On this continent, Pennsylvania leads in the product of this

most valuable mineral. Her production of anthracite, of which Schuylkill County yields about the half,

Is	. 7,100,000 tons.
Bituminous, Eastern Penna., about .	. 160,000 "
" Western " " .	. 3,000,000 "
	10,260,000 tons.

Or more than one-tenth of the whole product of the world.

Maryland will produce about . .	. 750,000 tons.
Illinois " " . .	. 350,000 "
Ohio " " . .	. 300,000 "
Kentucky " " . .	. 200,000 "
Virginia " " . .	. 175,000 "
Tennessee, Missouri and other States .	. 200,000 "
Total product of the United States	12,235,000 tons.

Let me briefly refer to what you have done in Pennsylvania, in order to furnish such a supply of this necessary article of fuel. We have in daily operation 790 miles of railroad and 656 miles of canals, constructed almost exclusively for this trade, and whithout which, the capital of $84,000,000 thus invested would be almost unproductive. But to come nearer home. What have you done in Schuylkill County? You have constructed more than 150 miles of railroad *under ground*, or tunnels. This is a fact which even you, gentlemen, may not realize without reflection. Only think of it. Why, even in the Atlantic cities a project for 150 miles of railwayis regarded as a great undertaking, even when foreign capital is relied upon, by issue of bonds for half the cost. Again, I am informed by one of great experience, that the capital required to be invested in engines, breakers, houses, &c., is, on the average, $750 for each 1000 tons of coal produced. Hence, there must have been materially more than one hundred millions of dollars invested in lands, and in producing and transporting to market this article of absolute necessity.

I have briefly alluded to the progress of the coal trade of Great Britain. Allow me, for one moment, to call your attention to the increase of production in our own State. In 1825 there were produced and sent to market—

	34,893 tons.
In 1830	. 174,734 "
1835	. 560,758 "
1840	. 864,384 "
1845	.2,013,013 "
1850	.3,358,893 "
1855	.6,635,790 "

I have promised more than once, gentlemen, to be brief, and I now will be, while I again admit, with such figures and results before me, I could go on talking all night.

It is not reasonable to assume that, with the progressive spirit of commerce, and, if you like, of conquest, that coal depots will be established over every portion of the globe accessible to commercial or naval steamers? But, gentlemen, if I proceed with these enlarged views, I shall never stop. I had intended to demonstrate the importance of the iron production, and its identity with that of coal, and to clearly exhibit that coal, as the cheapest fuel, was essential to domestic comforts, to our great manufacturing interests, to our naval and commercial marine in the competition with other nations, and, in short, to our national greatness in peace or war.

Art. V.—SUBMARINE MINING.

Habits of thought and conventional usage often give a significance in technological matters widely different from the primitive construction and understanding of common-place phrases and terms. We are in the habit of hearing terms of art and science used and applied in a given sense, which sense is more often in accordance with our own apprehension, than with a fair linguistic construction.

When one uses the world "*balloon*," we all know what it means, and its implications of circularity, levity and an aerial medium are fireside thoughts, but who understands the phrase or knows what is meant by the term "*salt-water balloon*," and could or would any of our preconceived notions or habits of thought disassociate it from an aerial medium, or suggest an aqueous medium for "*ballooning*."

We have been trying for some time to surmount the pile of old habits of thought and conventional usages and to fall into the "current" of discovery, and more particularly since we have attempted to find a name for the subject we are trying to get at in this article. We can readily *utilize* the means and implements of delving into mother earth, provided we have a small portion of her upper crust to stand upon; but when this crusty cuticle is knocked from under our feet, and we are required to commence our *mining operations* by a *dive*, not into the deep caverns of earth, but into the facile, mobile, unsteady waters of the sea, and to be *immersed*, submerged, surrounded by the very element which of all others gives us most trouble in our mining explorations, we frankly confess to some obtuseness in apprehending the thought.

We all know what "*mining*" means, and that it implies earth, rocks, stones, &c., and their removal by some mechanical means

and an expenditure of steam and *money*. Our old habits of thought enable us to conceive of shafts, adits and gangways, of panels, headways, and breastwork. But who understands what *submarine mining* means? the title of this article. Subterranean is an awkward phrase for a very comprehensible operation; but submarine mining is significant of some new *diablerie* of a resuscitation of Wernerian and Neptunian conflicts: or at least of an invasion into the dominions of father Neptune. It is a premonstration of aquarian monsters or miners, of coral grottos, and a total insertion or rather submersion of our ordinary ideas of undercrust movements. We have heard of a certain nymph by the name of Nais, a resident of the Red Sea, who amused herself by turning into fishes all who approached her residence; and of the Nereides, the fifty submarine daughters of that old Mormon Nereus, who were all fond of alcyons, bestrode the backs of Dolphins and acted as employees to submarine chief engineer Neptune; we are satisfied moreover that his submarine majesty was a pelagic geologist; for we are informed by Hesiod's Theog. that he stirred up sundry earthquakes, and by a necessary consequence water-quakes, and no doubt for the specific purpose of developing sundry non-conformable submarine formations.

Thus sadly was our philosophy puzzled after reading an invitation to attend an exhibition of the Nautilus Diving Bell, which, it was intimated, *rendered mining under water as practicable as on land.*

We embarked on the steamer Champion on a bright and cheery day in November last for Glencove harbor. The day was propitious, the company select and included many of our leading capitalists, and men of science, foreigners of distinction, and, although last not least, a large number of ladies whose fresh and roseate looks paid a just compliment to the fairy brightness of the day—the finest of our American Fall days. As we approached the upper end of the harbor we perceived a vessel at anchor, and near it a round, tea-kettle-looking thing reposing in quiet dignity, with its upper and spherical surface just out of water. In a few minutes it disappeared from view, and from sundry ebullitions and blowings we supposed it was preparing itself for some grand blow out. It however emerged without any disturbance, and sundry humans protruded themselves from its interior, not unlike miners from a shaft ladder. We availed ourselves of an opportunity to descend beneath the waters of the beautiful bay, and confess we do not remember when we had enjoyed so much gratification. The machine is very similar in shape externally to an old-fashioned English copper tea-kettle with its lid supported on an elevated rim, and called the Man-hole. Internally it has segments of the space cut off for buoyant chambers, still leaving room for seven to ten persons, inside. Sundry gauges valve-cocks, windlasses and cranks were all that occupied the interior, and the whole ar-

rangement was simple and effective in the extreme. On reaching the bottom of the harbor a trap-door was raised in the floor of the bell, and we stepped out upon the sandy bottom and picked up sundry shells and waifs as mementoes of our descent.

On returning to the surface of the harbor sundry good things of earth produced a prandial equanimity, and we fell into a brown study upon the manifest destiny of the machine and its involved principles, which study was disturbed by information that sundry speeches were about to be made. As mining is our leading idea and submarine mining our *mis*leading idea, we opened ourselves to any and all the information to be procured from the speakers. As the speakers were called up without any apparent arrangement and just as the vox populi suggested, our hopes for information were feeble. We listened to sundry capital and practical thoughts from some hale whole-souled sea-captains, and began to get light because they all talked common sense. But presently we heard Senator Hale call the machine a *saltwater balloon*, and Mr. Rankin talked largely of its applicability to *submarine-mining*. Here we were again fairly stuck, our drift had fouled upon a fault, a veritable dyke of non-conformable ideas, an elvan, that was all gossan (or gossip.)

Nevertheless the sober second thought came around; we had actually been down and had placed our feet upon the very bottom of old Neptune's dominions. If gold or coal, silver or copper had been there, why not pick it up as readily as we picked up the shells and waifs we found and which are now before us? and why not drill and blast rocks, and carry to the surface any ore-bearing materials as readily as great rocks and stones were carried about under water, as we shall presently see? In fact we became converted into a firm believer in the manifest destiny of the machine, and that destiny will be its general and universal use in all submarine operations. We see no difficulty in running out and tracing mineral veins under water, or in drilling, blasting and sending to the surface the disintegrated masses. For gold-prospecting and surface-gathering it must become of great value, as the practicability of sending more gold-bearing sands to the surface is feasible at all times and all depths. In the solution of geological investigations, now often impracticable on account of submersion, it will prove a most valuable auxiliary, and we shall have light where we now have only probabilities or deductions. We only allude to the machine at present, and shall give all earnest attention to its future developments and applicability to our own mining interests. By way of commentary upon our text we submit extracts from the report of Jesse Gay, Esq., Chief Engineer U. S. Navy, who was sent by government order to examine and report upon the machine, whose report is very interesting, under date of Dec. 9, 1856. He says:

"In compliance with your order of the 12th ult., I proceeded

to Glen Cove, and witnessed some experiments with the *Nautilus Submarine Company's Diving Bell*, which were made to test the power and adaptability of this apparatus for the construction of Wharves, Submarine Walls, Piers, &c. I have the honor to report that the Nautilus Submarine Co. gave me an opportunity to make such tests and experiments as I desired.

"With the assistance of two experienced persons I descended in the Bell to about twenty feet below the surface of the water; the time occupied to prepare the Bell and reach the bottom, was about two minutes and thirty seconds, and about a minute and a half to return to the surface. I found the machine very simple, easily managed, and perfectly under the control of the operator. It can be brought from the surface to the bottom of the water with considerable rapidity, or it can be moved up and down quite slowly, as may suit the convenience of the operator.

"When on the bottom, or resting on a work, the water can be expelled from the working chamber so that no more than one or two inches remain above the bottom of the Bell, and even this may be removed by an additional pressure of air in the working chamber; hence a great advantage in operating upon works or submarine blasting is obtained.

"Several blocks of granite weighing about four tons each had previously been prepared and placed on the bottom; the Bell was attached to the stone by a "*Lewis*," and brought it within four feet of the surface; the time occupied in securing the stone and coming up was about three minutes. The construction of the Bell would not admit the stone to be brought nearer the surface; this is sufficient for laying wall in tide water. Should it be required to perform work where the tides do not ebb and flow, auxiliary water chambers are attached, so that the work can be brought to within about one foot of the surface. I descended with the stone, and by the aid of two men transported it several feet laterally with as much ease as could have been done were it suspended from a crane, with the advantage of placing it at any point or in any desired position.

"I occupied the Bell forty minutes, performing such experiments as suggested themselves to my mind. I experienced no unpleasant sensations, such as are produced in the common Diving Bell by the action of the pump. When necessary to admit air, it is done so evenly, that all unpleasant sensation upon the ear is obviated; consequently men can labor longer and with less fatigue in the Nautilus than in the Diving Bell.

"It has advantages for the construction of Wharves, Submarine Walls, Piers, drawing and sawing off Piles, removing stone or other obstacles, examining bottoms, broken works and sunken wrecks, combined in no other machine, by having the power within itself of descending or ascending at any required points, without the aid of any apparatus on the shore, and of being moved at pleasure horizontally on or near the bottom.

"The simplicity of its construction, the ease with which it is operated, and being suspended by its own buoyancy, render the safety of those within not dependent upon the treacherous nature of iron or wood. Should the air pipe be separated or disconnected from the Bell, it contains the power within itself to be brought to the surface, thus rendering the loss of life from any conceivable accident almost impossible.

"It is my opinion, that with this machine properly managed, more than double the work can be constructed under the water, and with one half the expense, than by any other means, and I therefore recommend it to the favorable consideration of the Government."

The machine involves some of the most beautiful illustrations of applied science, and we hope that the attention of the American School of Mines will be given to its utilizing features.

Art. VI.—THE AMERICAN SCHOOL OF MINES.

The organization of such an institution has been alluded to in previous numbers of this Magazine; and the practical form suggested by Mr. Rankin, in his article in the October (1856) number of this Magazine, has been substantially adopted at a meeting of gentlemen ranked among the first in science and intelligence. This meeting was the second that had been held for the consideration of this subject, and resulted in the adoption of the following plan, which we copy from the printed "Articles" now before us:

Articles of Organization of the American School of Mines.

The persons named in these articles do hereby form themselves into an association with the title of "*The American School of Mines.*"

Objects.—The objects of the association shall be the development of the mineral wealth of the United States, and the determination of its economic values, instruction in the art of Practical Mining, and the analysis and composition of mineral products.

Organization.—The organization shall be as follows:—

First.—A Council of twenty-four members in whom shall be vested the supreme power and control, and who shall be chosen from the associates as the by-laws may direct. The Council shall have power to appoint all officers and employees, to make by-laws and ordinances, to appoint professors on the nomination of the Faculty, and determine the branches and terms of instruction. The members of Council shall allot themselves into four classes, one of which shall go out of office annually when an election shall be held to supply their places. Members going out of office shall be re-eligible. In case such annual election shall not be held, or a vacancy shall occur from any cause, the Council may supply all vacancies, and the persons so appointed shall hold their offices as if elected by the associates.

Second.—A Faculty to consist of Professors of Practical Mining, Dynamic,

and Economic Geology; Mineralogy, General and Analytic Chemistry; Metallurgy, applied Science, Physics, and such other branches of science and art as may become requisite.

Third.—A resident Curator of the Museum, who shall have the general supervision of the same under the direction of the President and Council.

Fourth.—An Assaying Office and Laboratory, and Mining Library.

Fifth.—A Museum of Practical Geology and Mineralogy for the collection and preservation of mineral products, and showing the application of their usefulness in the arts of life; models, plans, and drawings of mines; descriptions of deposits and basins; specimens of all the tools and implements used in mining; and generally every matter and thing in any way relating to, or capable of accomplishing the objects of the association.

Sixth.—Life Directors.

Seventh.—Honorary Directors.

Eighth.—Directors.

The qualification and privileges of the several classes of Directors, and the manner and times of holding elections—the duties and functions of officers and employees; and the mode of executing the incidental powers included in these articles shall be prescribed by the by-laws.

The Council shall always be elected from the several classes of Directors, but the Officers and Professors may or may not be, at the time of their election or appointment, members of the Association.

Directors.—Any person of moral character may become a Director by paying, within thirty days after his election according to the by-laws, the sum of ten dollars, and may continue such Directorship by the payment of such annual sum as shall be prescribed by the by-laws.

Life Directors.—Any person may become a Life Director by paying in semi-annual instalments the sum of three hundred and fifty dollars, and such payment according to the terms of the by-laws, shall thereafter exempt such Life Directors from future annual charges.

Alteration of Articles.—These articles shall not be altered without the consent of a majority of all the associates, nor until such alteration shall have received the assent in writing of two-thirds of the Council, and such alterations shall only be made at any meeting convened after two weeks' notice of the same. But nothing in this article shall prevent the substitution of a charter or act of incorporation in lieu of these articles with the assent of the Council, and which charter the Council is authorized to procure.

The following, with others to be hereafter appointed, shall be members of Council and Officers for the first year, and until their successors are elected:—

(Here follows a list of 20 out of the 24 Members of Council as far as chosen; but as the Board is not yet full, and some changes may take place by resignations, the list will be reserved for another number. The following gentlemen were elected officers as far as indicated by the printed articles):—

And Robert G. Rankin shall be President; ——— shall be Vice-Presidents; Charles M. Wheatley shall be Secretary; ——— shall be Assistant-Secretary; James T. Soutter, President of the Bank of the Republic, shall be the Treasurer.

And all the Officers shall severally hold office during the pleasure of the Council.

One striking feature of this plan is its very *practical character*, and freedom from all fictitious notoriety. It will be in every sense a *utilitarian school*—and in its present form has not yet been attempted in our country. Its adaptive character and adjustment

to the progress of our mineral development, will recommend it as warmly to our capitalists as it has to our leading scientific minds.

We have procured the proof-sheets of the forthcoming *outline of its plan of operations, which we print in full:—*

THE AMERICAN SCHOOL OF MINES.—PAPER NO. IV.

Outline of Plan.

The objects of the *American School of Mines* being the economic and scientific development of the *mineral wealth* of the United States, and instruction in the art of Practical Mining, its inception and outset movements will necessarily be adaptive.

It is not expected that the institution will commence with or become dependent upon large endowments as conditions of its existence, but on the contrary, will lay out its early movements upon a moderate scale, avoiding all indebtedness, and will start upon and evolve the *self-sustaining principle* (after the first year of its existence.) Imitating the inceptive movements of a similar (European) school, it will endeavor to impress upon the American mind the value of such an institution (in this country hitherto untried); and by the force of its own merits and identification with the best interests of our mineral wealth, to grow from a moderate beginning to a popular and national institution. By adjusting itself to the progressive development of our mineral wealth, and adapting itself to a *practical* and *utilising system*, it is believed that it will grow with the growth of our institutions, and with the gradually increasing appreciation of its true value and importance. Its objects appeal directly to marked characteristics of the American mind, and as the knowledge of its plan and objects becomes diffused, a corresponding interest and support will be afforded to it.

Resources.

Resources will be derived as follows, from—

Initiation Fees ($10 from each Director.)
Life Directors ($350 each.)
Assays, Analyses.
Enrolment of Mines and Mineral Properties.
Models of Mines (sales and deposits.)
Draughting and Drawings of Mines.
Donations.
Mineral Cabinets
Publications.
Agencies.
Exchanges with Colleges, Academies and Schools, and
Sales to Students and Amateurs in Geology and Mineralogy,

and other collateral resources growing out of the above.

Few persons are aware of the very large sums of money paid weekly in this city for assays and analyses of our varied natural products; and to this requirement it is intended that particular attention will be paid.

Assaying Office and Laboratory.

This office will be conducted on the most scientific and practical principles, and will be under the management of chemists, and gentlemen experts in applied science, and as skilful as are to be found in the United States. It is intended that regularly certified analyses of the American School of Mines shall have the perfection, truthfulness, and reliability of any Government Mint Assay, *and the manipulators shall be entirely disinterested in results.*

The Assay Records shall be open to the public, by which (for a trifling fee) any person, in any way interested in mining stocks or mineral products, may form his own judgment of valuation, or may procure an analysis for himself. All analyses will be beyond the suspicion of interested motives, as the institution will alone be known as responsible for the truthfulness of the analyses.

Museum of Practical Geology.

Another feature in the outline of our plan of operations will be the establishment of a *Museum of Practical Geology and Mineralogy*. This part of the plan will probably expand largely from the very first movement, as large collections have been already tendered; and it is thought that one of the most valuable collections of minerals in the United States may be secured as a loaned deposit for a nucleus. Many friends have already tendered fine specimens of the iron and copper ores of the United States. In carrying out the leading principles of economy and prudence in the inceptive movements of the *School of Mines*, rooms at a moderate rent will be secured, and no outlay will be encouraged for expensive buildings.

The *Museum* will be divided into departments specially adapted to illustrations of economic Geology, Mineralogy, and Mining, and among others as follows:—

Iron Ores.—A complete suite of all the known iron ores of the United States, and their associated rocks, characteristics of their veins, gangues, &c. —directions for examination of mineral veins—the constituents of the ores—specimens of the various kinds of merchantable or manufactured iron made from each, and their applicability to specific purposes in the arts and trades. Models and plans of the furnaces for the *reduction* of the ores—and illustrations of the whole process, and of each condition of the process of reduction.

Copper Ores.—Suites of all the known copper ores of the United States, with illustrations of reduction and manufacture as in the department of iron ores. It is believed that very erroneous impressions prevail in relation to the extent and true value of our copper ores, and that some place where correct information, collected and condensed from various deposits and smelting furnaces, may be found, will save heavy pecuniary losses.

Lead Ores.—These ores and their varied salts form some of the most brilliant specimens in our collections. A full suite with associated rocks, description of veins and deposits—process of reduction—mode of parting silvery constituents, and directions for exploration, will prove useful to many who are now throwing away time and money ignorantly.

Zinc Ores.—The same items of information as on the other ores, modified by the limited extent of their deposits.

Gold and Silver.—The same illustrations as of the other ores.

Coal.—*This great element of national vitality* will have ample illustrations of its formations, extent and localities in the United States, mode and cost of mining, data relating to its consumption, and models and plans for its combustion. Providence has filled our earth with every kind of coal that can be required for every kind of purpose, and deposited these kinds on the very centres of our future population—it only remains for man to adjust and adapt the process and mode of combustion of each particular coal to the purpose required—*not to attempt to use any one kind for every purpose and condemn it because it fails; this is the great error of the day.*

The *American School of Mines* will endeavor to correct such errors by facts and illustrations. The use and mode of use in locomotives will be demonstrated. Maps and designs will be published from time to time, showing all the coal deposits of the United States.

Marbles.—This department will exhibit marbles as beautiful and varied as can be found in any country. Their composition, durability, and utility will also be illustrated.

Clays, Marls, Green Sands, &c., will present a department of exceeding

interest, and our citizens may learn that we are importing from abroad manufactured articles made from crude materials exported from our own deposits.

SANDSTONES AND BUILDING MATERIALS.—Specimens of our sandstones would alone fill a large department. The gradual introduction of an *American order* of architecture and its adaption to our climatic requirements, will give to this department an economic value equal to any other in the Museum.

SALINES, PETROLEUM, SILICIOUS SANDS, Materials for Soils, Peats, Materials for Engineers, Canal Embankments, Abutments, &c., Well-digging and Springs, will all find their appropriate illustrations of industrial relations and economic values.

Mining.

The Department of Mining will of course present objects of great interest to the comparatively uninformed mind of our citizens. Providence has so deposited our mineral products as to render them comparatively accessible without that enormous outlay of capital so usually necessary in other countries. In this department will be found in time, the models of steam engines and all the machinery and tools necessary for mining purposes, models for pumping water, safety plans for ascending and descending shafts, apparatus for washing and dressing ores, instruments used in dialling, levelling, exploring, &c.; models of shafts, inclines, slopes, &c., and average cost; system of ventilation, difference and comparative economy of the old Stall and Pillar system, and the modern Puddle system will be shown by models and drawings.

Geology and Fossilogy.

The Museum will be rich in illustrations of these interesting subjects, as State Reports and Surveys, Maps and Specimens, and Casts, have been already tendered by our leading Geologists and Palaeontologists.

Mining Library.

A Mining Library will be procured as fast as practicable, and mining serials will always be accessible to the public.

Lectures.

A system of Lecturing on subjects appropriate to the objects of the institution will be delivered by the Professors and gentlemen connected with the institution; and lectures will be delivered at proper seasons in different cities of the Union at the same time. Professorships will be established in each city. By this means the institution will be diffusing in all parts of our country the information it has condensed.

Sphere.

Although very properly located in the city of New York, where capital and mining interests concentrate, and are most extensively represented, yet its sphere will be national and its operations only limited by our national boundaries.

Papers.

Papers will be published from time to time on subjects connected with its objects.

Honorary Directorship.

This class will include our leading scientific men, who by the articles will, in person or by proxy, have a voice in the selection of the Council.

Mining Tools.

Specimens of every known tool used in the mines of both Continents will be exhibited, with cost and place of manufacture.

General Information

On all subjects connected with the institution may be procured by addressing either of the officers, New York City.

JOURNAL OF MINING LAWS AND REGULATIONS.

Edgar W. Voris, *agt.* D. A. McCredy and P. J. Armour.

SUPREME COURT—*Special Term*—DEC. 16—. Before Judge ROOSEVELT.

This bill is filed to get rid of the consequences of an unfortunate speculation in Gold Hill stock, on the alleged ground of fraud and misrepresentation.

ROOSEVELT J.—The plaintiff says that he is a practising physician in the town of New Rochelle, and from that circumstance it is presumed would have the court to infer, although he does not aver it in express terms, that he is not versed in the ways of Stock Exchange; whereas the defendants, he says, although one of them (McCredy) has his residence in the country, are city note-brokers, doing business in Wall Street.

The plaintiff and defendant McCredy, it is also alleged, were in habits of social intimacy, the former being not only the neighbor but the family physician of the latter, and as such making frequent visits, both friendly and professional, to his house in the country; on one of which occasions, in a summer evening, in the month of August, 1854, the conversation it appears turned upon the state of the stock market, and more particularly upon the probable advantage of a suggested investment or speculation in the "Gold Hill Mining Company," of which McCredy said he had purchased for himself two thousand shares, the market price being three dollars per share. The doctor being thus given to understand that a pretty large operation in stock might be undertaken upon "a very small amount of money," after a few days' reflection and inquiry, and without any persuasion from McCredy, concluded to try his fortune. He accordingly provided himself with the necessary "margin," as it is termed, of $125 for a purchase of five hundred shares, and paid another visit to McCredy, determined, as he said "to see what there was in this Gold Hill." McCredy, at his request, took the money and undertook to make the purchase at a price not exceeding $3 per share. "The doctor (says the witness in whose presence both conversations took place) was there, at McCredy's house, about an hour," discoursing, among other subjects, upon golden stock prospects, and evincing a high degree of confidence in regard to them, in which McCredy fully, and I think honestly, concurred. Up to this point, whatever may subsequently have been the doctor's suspicions, there is no ground whatever in the evidence for a charge of fraud. The delusion, if any, was mutual. Both parties were alike self-deluded, or alike deluded by others.

Subsequently, however, McCredy in repeated conversations—contrary, it is alleged, to the fact—informed the doctor that he had made the desired purchase at the rate agreed upon, of three dollars per share. He went further—on the 24th day of January, 1855, about five months after the first interview, he presented him a written account with a charge "to cash paid for Gold Hill stock, Sept. 1, $1500. Interest to January 24, 145 days, at 7 per cent, $42 29."

It now appears that there was no such "cash paid" and no such purchase made. And the plaintiff, therefore, claims that the money he advanced, and also a subsequent small payment should be refunded to him, and his note for the balance should be delivered up to be cancelled. To this claim it is objected by the defendant that on the 1st September, 1854, a few days after Dr. Voris had requested the defendant to purchase for him, as already stated, five hundred shares at $3 per share or under, he, the defendant did in fact purchase of Morgan & Co. that number of shares. But the purchase, it appears, was in his own name, and for twenty-one instead of twenty-four shillings per share, and not for cash but on time, deliverable in "sixty days, seller's option," and not in fact delivered and paid for till the 30th of October, the last day of the option.

The purchase so made is clearly proved; and the defendant alleges that it was made in execution of Dr. Voris's order—an allegation which, though probably true, is not legally proved, and is inconsistent with the account presented to Dr. Voris, on which the note was given. And the question is: Under the circumstances, can McCredy now charge the doctor with the price of those five hundred shares, as an investment made on his (the Doctor's) account. It seems to me he cannot—first, because it is at least doubtful whether a purchase at sixty days, "seller's option," was within the authority delegated to him; secondly, because he is estopped by his own reports, both verbal and written, of the terms of sale, from saying that the contract, instead of being "for cash," was an optional one on the part of the seller as to time, and at a rate of two and five-eighths, instead of three dollars per share; and thirdly, because, if not estopped from proving, he has not in fact proved that the purchase which he made, so different from the one reported, was in truth a purchase for D. Voris instead of himself, in whose name the contract was made. His answer in that respect, although duly sworn to, and although containing a very natural explanation of the transaction, is not, under the present system of procedure, such evidence in his own favor as the Court can act upon. It may satisfy any mind, as it certainly does mine, that no moral wrong was intended, and that to throw the loss in this case upon the defendant, when all the gain, had there been gain, would probably have gone to the plaintiff, is a great hardship; yet, viewing the matter judicially, I am compelled to decide that the defence is not established. Under the circumstances, however, and in the exercise of that discretion, which in equity cases the law confers upon the Court, I deem it proper not to charge the defendant with either interest or costs.

Judgment to refund the two payments, and surrender the note.

COMMERCIAL ASPECT OF THE MINING INTEREST.

MINING STOCKS IN BOSTON.

BOSTON, *Jan.* 1, 1857.

Compared with a month since, the mining share market has improved materially, and there is a much better demand for the different stocks than at that period. We do not recollect a time when the shares of reliable mining stocks were so scarce as at present, and it is very difficult to fill orders, even only moderate ones, without putting off prices at once. One cause of this state of things, and a very important one too, is the large advance in the price of ingot copper (3 to 4 cts. per lb.) which adds materially to the value of the stock in those Cos. which are producing considerable amounts of copper. To the Minnesota or Pittsburg Cos. this advance would make a difference of about $100,000 in the product of 1856, provided it could all be sold at the present price of copper—30 cts. per lb. As it is, however, the advance will increase their *net* profits some $8,000 *per month.*

Minnesota, at the date of our last article, was selling at $98 per share, and quoted dull. After that the price was run down, by parties in the "bear" interest, to 92½, from which, however, it immediately rallied and has since steadily improved, until 103 is now the lowest price for it. The *certainty* that this Co. will divide (in March) $10 per share on 20,000 shares for the profits of 1856, and the strong *probability* that the dividend will be $12 to $15, renders the stock desirable even at the present comparatively high prices.

Land and Copper Mining Companies.	Par	No. Shares	1856. Highest & Lowest.		Shares sold in 1856	1857. Jan'y 1.	Feb'y 1.	March 1.	April 1.	May 1.	June 1.	July 1.	Aug. 1.	Sept. 1.	Oct. 1.	Nov. 1.	Dec. 1.	1857. Jan'y 1.	1856. Div'ds.
Copper Falls (paid in)	$20 00	20,000	71	1	4857	7½	4½	5	5½	4	4½	4	8	‡3	‡3	1	1	‡2½	0
Isle Royale do	14 00	12,000	19	4½	28957	12½	11½	13	15½	17	16	19	15½	12	10	4½	5½	6¼	0
Minnesota do	8 80	20,000	103	43	3240	42	45	50	68½	78	74*	95	80½	90	94	103	96	101	$5
National do	11 00	10,000	43	10	630	‡10	15	21	31‡	30	29½	42	35	29½	26	26	27	31	0
N. American do	23 50	9,000	40	25	15	20	25	30	30	30	38	35	33	33	25	25	25	25	0
Pewable do	1 75	20,000	5½	1½	10644	1½	1½	2	3	3½	3	5½	4½	4½	4½	4½	5	5½	0
Pittsburg do	18 50	6,000	975	180	340	150	180*	190	220	220	250	275	225*	230	220	233	227‡	237	$10
Rockland do	9 00	20,000	35	18	4991	13¾	13	18¾	19	25	20	28	24	28	30	35	32	35	0
Superior do	1 00	20,000	10	6	523	- -	- -	- -	- -	- -	- -	6	6	7	7	‡9	10	9	0
Toltec do	15 00	20,000	8	‡	41130	6	8‡	6½	7½	4½	4½	9½	14	‡2½	‡	‡	‡	‡	0

*Ex-dividend. ‡Copper Mining Stocks assessment paid.

Pewabic has advanced from 4½ to 5¾, and is steadily gaining strength among those who buy mining shares for investment on their intrinsic value. The product for the year is now ascertained to be 110 tons, having exceeded the estimates of the most sanguine.

In this amount the stamp work, equal to 50 tons when prepared for market, is not included. The profits for the past year will afford ample funds for prosecuting the work throughout the winter, and the future of the concern is every thing that could be hoped for by the shareholders.

Quincy is wanted at 8 bid and none for sale less than about $10. No sales have been made for the month. Flint Steel River is in more demand at $4 bid, which is an improvement. *Central* is heavy at $5 without sales for a long time. Copper Falls has lately been assessed $2 per share, and now sells at 3¼ with a good demand. It is hoped and believed that the future of the Company will be more successful than the past. *Toltec* cannot be sold at any price now, but an assessment of $1 per share will be due Jan. 8, which may bring it into life again.

We are without advices from the Lake since the close of navigation, and a mail is expected at any moment. The report that the mines were without their usual supply of powder is an error entirely.

PRICES OF MINING SHARES FOR 1856.

The following bird's-eye-view of Mining stocks in Boston for the entire year 1856, we copy from an appendix to "*Martin's Twenty-one years in the Boston Stock Market*," issued by Joseph G. Martin, No. 10 State Street. The marked improvement in Minnesota, National, Pittsburg, Rockland and others cannot fail to attract the attention of parties interested in Mining enterprises.

Pittsburg (Cliff) has an upward tendency, and the shares are now scarce at about $140, an improvement for the month of full $12 per share. The dividend period (Feb.) is drawing near, and it will not be less than $15 per share for 6 months on the 6000 shares. The stock is very scarce, and the position of the concern was never more flattering than at this time.

Rockland is very firm and scarce at 35 bid, and no amount of stock could probably be obtained under $40 per share. The Company have done very much better than had been previously anticipated, the yield from February 1 to November 1, (9 months,) having been 190 tons. The stock is mostly held by parties who look for much higher prices in due time.

National is in demand at 33 and very little stock on the market. The Company is now making a profit on its monthly product, and it is hoped that no farther calls on the shareholders will be deemed necessary. *North American* is more inquired for at 25 to 30. This stock is very seldom sold in the Boston market. The Company has been more successful the past year than in 1855. *Superior* is not active, but is wanted at 8½ to 9. We presume that farther assessments must be levied for operating the mine, and this probably tends to keep off buyers.

Isle Royals has advanced from 5½ to 6½, and is now much scarcer than at the lower price. A great effort has been made to depress this stock, and every thing has been done by interested parties to frighten holders into selling, by raising the "bugbear" of *assessments*, &c.; but those who know it best seem ready to buy the stock and keep it for future results. From present appearances they will not repent of their bargain. It is *possible*, though not probable, that an assessment may be called for in the spring, but this will depend, in a measure, on the success of the present winter's work.

COALS AND COLLIERIES.

ANTHRACITE COAL TRADE for 1856.

The trade by the Schuylkill Canal closed early in December, about the time the fiscal year of the Railroad also closed. The total quantity sent by Canal is 1,169,296 08 tons, against 1,105,263 08 tons last year. Increase in 1856, 64,033 tons, making the whole supply from the Schuylkill Region for the fiscal year by Canal and Railroad, as follows:

	1855.	1856.
Railroad	2,913,392	2,089,208
Canal	1,105,263	1,169,296
	3,918,655	3,256,504
	3,256,504	
Decrease in 1856,	60,151 tons.	

This does not embrace the Pinegrove or Swatara trade by Railroad South, which shows a slight increase this year over the last

The increase in the supply of Semi-Anthracite and Bituminous will be E—

the neighborhood of 100,000 tons over the supply of last year, which exhibited but a slight increase, if any, over the shipments of 1854.

SUPPLY OF COAL.

The supply of coal, we think, will be sufficient for the market, if properly distributed. The apprehension of a short supply greatly stimulated the demand for the last two months of the shipping season, and has thus secured a supply of coal sufficient to keep down high prices in the different markets, except at some few points where a sufficient number of vessels could not be obtained to secure a full supply. The Philadelphia, New York and intermediate markets, can be reached now throughout the whole season, and although the expense of transportation to the carrying companies is considerably enhanced in the winter season, still they afford an outlet to market for the gangway coal, which is taken out in the preparation of the mines for next year's business, and thus aid in keeping down high prices when these markets are inadequately supplied.—*Pottsville Journal.*

REORGANIZATION OF THE COAL TRADE.

John Tucker, Esq., visited our Region this week, for the purpose of perfecting the plan, which he has devised and submitted to the Trade, for a thorough reorganization of the entire coal business. There is no doubt that the plan will be adopted with almost entire unanimity. With the exception of one or two shippers—who may yet see the feasibility of Mr. Tucker's suggestions—all appear disposed to unite and give the plan a fair trial. The more we think of the matter, the stronger are our convictions that every branch of business, connected with and dependent upon the Coal Trade, will with it be benefited by the adoption of a head to systematize and regulate the operations of the Trade. The marked benefits arising from the adoption of such a plan, will be a greater equalization of the business between the different interests, and an assurance to the operator that prices cannot fall below a fixed standard. We feel confident that at least from 10 to 15 cents a ton can be saved to the operator, without enhancing to the consumer the price of coal a single cent. Let those engaged in the business consider that ten cents a ton saved on the coal product of the present year—3,300,000 tons—would amount in round numbers, to the snug sum of $330,000—and 12 cents per ton saved to the operator on that product, would amount in the aggregate to $396,000. A prominent reason why the operators *en masse*, of this Region, should enter heartily into the plan proposed, is that even those who mine the best coal, and experience a steady demand for it, are affected equally with those mining an inferior article, by irregularity in the Trade. They would commit a grave error by refusing to enter into an arrangement, calculated to enhance the value of their product, while all must admit that it would be exceedingly unfair for any operator to withhold countenance from the experiment, and partake of the advantages attendant upon its success, without fostering it in its infancy.

While we are confident that the plan proposed by Mr. Tucker for the reorganization of the Coal Trade, will, if given a fair trial, result in material benefit to every interest concerned, we earnestly urge all to unite heartily upon the proposition, and put it to the test of untrammelled action.—*Pottsville Journal.*

RECENT EXPERIMENTS IN COAL BURNING LOCOMOTIVES.

The following articles furnished to these pages by Dr. Wyner, presents some interesting and valuable facts relative to coal burning locomotives.

The rapid disappearance of our forests, and the increase of the price of wood, has for some time past caused the attention of intelligent railroad managers to

be directed to coal as an article which must at no distant day supersede th use of wood for locomotive purposes.

Two very important difficulties have hitherto presented themselves in th use of coal, which have prevented, up to this moment, its general use as steam-generator: the one is the immense quantity of smoke evolved in it combustion, and the other the want of an economical apparatus by which it various products shall be consumed and made to evolve the largest amount c heat it is capable of producing.

In England and on the continent, where coal is in almost exclusive use o locomotives, the first defect is remedied by the use of coke, and the secon by a system of rewards given to engineers whenever they shall have consum ed less than a specified amount of fuel in performing a given duty. Their re wards are proportioned to the extent of economy in the use of fuel, and are s potent in their effect as to have diminished the consumption by at least one third, and far below the general average on our most economically conducte roads.

In this country, economy has been sought in the adaptation of the loco motive to the use of coal, rather than in the carefulness of the engineer; an it has consequently happened that a large number of differently constructe locomotive boilers have from time to time been presented, for the purpose o consuming coal; amongst the more prominent of which are Phlegen's, Dimp fel's, Latta's, Bayley's, Baldwin's, Millholland's, Baker's, Winans's and Board man's.

That of Winans is, up to the present time, the one most extensively in use and from which the greatest number of practical results have been derived This locomotive is adapted to the use of bituminous and anthracite coal, an is very extensively used with the former on the Baltimore and Ohio Railroad and with the latter upon the Reading Railroad. The peculiarity of this engine is its fire-box, the grate of which is seven feet long, and allows a larger sur face than ordinary for combustion. The arrangement of the tubing is the same as in ordinary boilers.

In neither of these differently constructed coal-burning locomotives, nor any other that has come under our notice, except that of Boardman, has any attempt been made to abate the quantity of smoke evolved, which is found in practice to be so abundant as entirely to preclude their use as passenger en gines, and to render them very disagreeable as tonnage-locomotives.

The consumption of fuel is necessarily dependent upon a variety of circum stances, which may vary with every road, and almost with every train upon the same road—as the weight of train, speed, grades, curvatures, and even the condition of the atmosphere. Estimates however may be made, by which the relative economy of one or the other of the locomotives may be tested with a considerable degree of accuracy. The practical result of the working of the Winans engine upon the Baltimore and Ohio road, when used on freight trains, shows an average consumption of about fifty pounds of coal per mile. Neither upon this road nor the Reading Railroad, has it been found practica ble to evaporate much over six pounds of water with one pound of coal. Ten trips made by the New Hampshire (a Winans engine) on the Reading road, showed an evaporation of 84,092 gallons, or 672,736 pounds of water for 110,096 pounds of anthracite coal used, or six and eleven-hundredths pounds of water for one pound of coal.

Mr. Nichols, the engineer and superintendent of the Reading road, in com menting upon this result, says: "Coal cannot be considered as absolutely eco nomical, until a higher evaporating duty than six pounds of water is obtained from one pound of coal." The English Cornish engine, when stationary, and placed under the most favorable circumstances, has succeeded in evaporating nine pounds of water with one pound of fuel. The appliances of a stationary engine are much better than those of a running locomotive, and it is conse quently found to be impossible to perform a like amount of duty upon a loco motive as upon a stationary engine of the same character and capacity.

The most successful experiment in England, which has come to our knowledge, is that of the Britannia, planned by Joseph Bettie, on the London and Southwestern Railway. The Britannia has a fifteen-inch cylinder, and seven-feet driving wheels. She is so arranged as to burn a mixture of coal and coke introduced into different apertures and in small quantities. The ordinary division of the fuel is two-thirds of coke and one-third of coal. The Britannia has run nearly 20,000 miles on the Southwestern Railway, with a large saving of fuel, ordinarily consuming less than twenty pounds to the mile, and evaporating eight pounds of water to each pound of fuel—the most favorable experiment shows an evaporation of 8.3 pounds of water to a pound of fuel. In this particular instance the pressure, although usually at 100 degrees, stood a portion of the time at nearly 115 degrees.

The most satisfactory result yet obtained in this country, and the only one which will at all compare favorably with those of Europe, are derived from the trials made with locomotives constructed on Boardman's plan, on the Providence and Worcester, and the Jersey City and new Brunswick Railroads. The trials upon both of these roads show an entire consumption of smoke and a large saving in the amount of coal consumed. The Phenix, constructed upon the Boardman principle, ran up to the 23d of October last, on the

New Jersey road	5,698 miles.
Consumed	193,952 lbs. coal.
Coal per mile	34.4 lbs. coal.
Average train	8.28 cars.

Each of these cars had two six-wheel trucks.

Run with Philadelphia train and express	34 trips.
" " Trenton freight	20 "
Presure of steam	85 to 100 lbs.
Running time per hour	45 miles.

No attention was paid to the number of pounds of water evaporated. The experiment made upon the Providence and Worcester road with the Slater (a Boardman engine,) was very thorough, and indicates the amount of water evaporated in the trial.

The amount of coal consumed in this experiment, which was continued for eight days,

was	38,100 lbs.
Water evaporated	299,880 "
Do do, to 1 lb. of coal	7.87-100 "
Steam pressure to the inch	100 "

This trial shows an evaporation of nearly eight pounds of water to one of coal, and will compare favorably with the best results obtained on locomotives in England.

The cylinders of the Slater are	14 1-2 inches.
Driving wheels	5 feet
Surface in fire-box	9 "
Do do flue-chamber	72 "
Do of tubes	872 "
Chimney	14 inches.
Diameter of blast-orifices	3 1-2 "

The chief peculiarities of this locomotive are its expansive and commodious flue-chamber, surrounded by water, occupying the upper part of the locomotive, and the vertical arrangement of its tubes in short pieces at the bottom of this chamber, through which the flame passes in a downward direction after it is thoroughly ignited.

In accounting for the many failures which have hitherto attended the attempts to consume coal in locomotives, it is necessary to say a single word in regard to combustion itself, so far as it applies to this article of fuel. "Two essentials," says Sir Humphrey Davy, "are indispensable for combustion, heat and contact." Now, heat may easily be generated in the fire-box of a locomotive, and yet its efficacy be destroyed by a want of contact with the inflammable

materials. This may happen in two ways—*first*, by the mixture of non-combustible gases with the inflamed particles, as in the case of Philips's fire-annihilator, and *second*, by coming in contact with cooling bodies. In the ordinary locomotive boiler the wood or coal is no sooner ignited than the flame is driven into the numerous tubes of which the boiler is composed, and is rapidly extinguished by coming in contact with a cooling body. Hence a large part of the gaseous products of combustion is driven off in the form of smoke, and so far from being useful, is absolutely converted into a source of great nuisance.

Says C. Wye Williams, in his excellent work on coal burning:

"On looking into a tubular boiler across the smoke-box, the light of the flame may be seen through the tubes; but on entering their orifices, or at a short distance within them, it will appear to be suddenly cut short and extinguished, and converted into smoke."

That the temperature *within the tubes* will be reduced below that required for continuous ignition, may be tested by looking into them through the apertures across the smoke-box end, or by introducing shavings or papers fixed to the end of an iron rod. In most cases (unless when fuel on the bars is clear) the paper may be passed in and withdrawn, blackened with soot or unscorched, according to the state of the furnace, indicating the low temperature within the tubes, and their utter uselessness as *steam-generators*.

Looking, then, at the practical effect of these numerous narrow orifices, and the diminution of the temperature consequent on its division, it would be impossible for ingenuity to have devised a more perfect mechanical mode of effecting that rapid and intimate contact so effective to the extinguishment of flame alluded to by Sir H. Davy.

The favorable results obtained in the experiments made by the Slater, are doubtless entirely due to the faithful observance of these laws in the construction of the interior of the boiler. There can be no doubt that an important step in advance, in the adaptation of coal to locomotive purposes, has been made; and now that the indications are rendered obvious by actual results, we do not entertain a doubt but if defects still exist, the well known ingenuity of our countrymen will find the means of remedying them.

The greatest marvel of this whole matter is, that with the principles of combustion as enunciated by Sir Humphrey Davy, well understood and recognised by every scientific man since his time, they should remain unapplied to coal-burning in locomotives until this late day. One reason for this is to be found in the fact, that in the combustion of wood and coke in locomotives, the gaseous products are less abundant and more easily consumed than those of coal, and they may be burned in an engine less perfectly constructed than that required for the use of coal.

An experiment has recently been conducted on the Boston and Worcester road with the Hecla, with Baker's curves, showing an average consumption of 54.4 pounds of coal to the mile, and another on the New Haven road with Crocker's coal-burner, but in neither of these instances have they been conducted with sufficient care to enable a comparison to be instituted. While we recommend this subject to the attention of those interested, as well worthy of their consideration, we would, at the same time, suggest the propriety of so conducting the experiments as to enable an accurate comparison to be made of the whole. The economy of fuel is so important in railroad management as to constitute the whole difference between a dividend and non-dividend paying concern; and too much stress cannot be laid upon the necessity of ascertaining, by exact experiment, the most economical mode of using it.

SHAFTS IN ENGLISH COLLIERIES.

We have often had occasion to notice the letters of a European correspondent of the Pottsville Miners' Journal, and occasionally made a brief extract

from some one of them. The information which they contain relative to the English collieries is of the latest date, and obtained by a reliable observer. We express the hope that all these letters will hereafter be collected and published in a volume form. Some interesting particulars relative to the depth and cost of some shafts in England, will be found in the subjoined extract:—

I concluded my last letter on the subject of Shafts, with an instance of a colliery, visited by me in the bituminous district of South Wales, where the shafts of inconsiderable depth, averaging about 100 feet, were completed at an expense of less than a thousand dollars for those 6 and 8 feet in diameter, and a little over $1200 for those 18 feet by 10. This being at the rate of $6 50 per foot, for the narrow pits, and about $11 50 for the wider ones.

Here then, at this colliery, are *seven* openings to the outside air—not including the "levels," of which there are several driven in on the crop of the veins—completed for less than one-twentieth of the expense that would ordinarily be incurred in the Newcastle District, for sinking a single shaft of 900 or 1000 feet in depth. If any where then, here at least, the ventilation should be abundant, and that in reality it is so, may be judged when I state, that through this net-work of mines which compose Rhymney colliery, there is made to circulate a current of 200,000 cubic feet of air per minute.

Many of the shafts in the *North of England*, have cost between $250 and $300,000, and there are some instances of shafts having cost more than double that sum. Hence, where such an enormous expense must be encountered, it cannot be expected that *many* should be sunk—and accordingly we find that one, or at the outside two shafts are made to answer for the whole establishment, though it may extend over hundreds of acres. The Howgill colliery, for instance, is over 2000 acres in extent.

In these cases, the element of great depth is of assistance in facilitating the ventilation, for, while in the case of Rhymney above cited, there were seven shafts with six furnaces, required to produce a ventilation of 200,000 cubic feet per minute, in the Hetton colliery of the North, a single shaft 900 feet deep, with three furnaces, is competent to produce a current of 140,000 cubic feet of air in a minute; and the coal consumed in the latter case is much less.

But it is not the element of depth only, that is the cause of the enormous expense of these pits in the Newcastle region, but the abundance of water and quicksand met in sinking them. In many other districts of England, you are told that shafts can be put down upwards of 600 feet for $4 00 or $5 00 per foot, which would make the entire cost of a shaft about $3000. In some of the Midland counties, the cost of a shaft of 600 feet depth, beginning from the first, would not exceed $10 or $15 per foot, with masonry. About $9000 would complete such a shaft—no quicksands and feeders of water being encountered—and no iron tubbing, or at least very little being required.

Throughout other parts of England, shafts of 8 feet diameter, and 600 feet depth, are ordinarily sunk, and walled for $5 per foot, and one of 11 feet diameter for about $8 per foot.

The "Cannel Mine" at Incehall, Lancashire, which I visited, cost $10 00 per foot for sinking—the depth being 600 feet. In this, there was considerable cast iron tubbing, jointed with timber—60 yards in all—which is not included. The *Pendlebury mine*, near Manchester, which I also visited, is 1560 feet deep. The two shafts, upcast and downcast, of which one was lined with iron tubbing to within 400 feet from the bottom, I was informed, had cost, including pumping engines and all machinery, no less than $200,000.

In *South Staffordshire*, the shafts, usually of slight depth, small diameter, and encountering no water, are sunk at an astonishingly low rate. One which I descended near Dudley, to view the "thick coal" bed, had cost less than $2 75 per foot—the depth being 360 feet, and the diameter 6 feet. I have even

been informed, that in this district, shafts are sometimes sunk and walled to the depth of a hundred feet, for as low as £1 a yard, or about $1 62 per foot. Such a pit, I was informed by a mining engineer in South Wales, would there cost three times as much, or about $5 00 per foot. He had visited Staffordshire, but could not understand how they were sunk so cheaply.

In no part of England do the difficulties of quicksands and water—requiring pumping, tubbing, and all the expensive and complicated engineering of shaft-sinking—appear to be met with, as they are in the north of England.

There, where feeders of water occur, sometimes, as in the case of Haswell mine, giving forth 1000 gallons per minute from a single feeder; where metal "tubbing" is often required to be inserted, as in the case of Harton Winning, for a length of 500 feet, the expense is often vastly beyond what would be due to the great depth alone.

It has been stated by Nicholas Wood, a distinguished Mining Engineer of the North, to show the effect of these difficulties in increasing the expense, that at *Seaton*, in the Newcastle district, a shaft sunk by him, cost between $250 and $300,000, including machinery, "whereas, a pit about two miles distant, cost much more than double that sum."

It may be interesting to append a list of a few of the numerous collieries in England, that exceed 1000 feet in depth. *Monkwearmouth*, the first of these, is the deepest coal mine in the Kingdom: and though not the most costly one, is said to have required an expenditure little short of $500,000.

List of some of the Collieries in England that exceed 1000 *feet in depth:*

	Feet Deep.
Monkwearmouth,	1800
Ashton-under-Lyne,	1800
Pendlebury Colliery,	1560
Dawdon, in Durham,	1488
Harton,	1200
Arley Mine, Incehall,	1248
South Hetton,	1212
Dukinfield Colliery, Cheshire,	1200
Howgill Pit,	1100
Castle Eden,	1088

But even the largest of these must yield the palm to the almost fabulous copper mines of Cornwall. That is the land of *depths*, where the cautious Tributer follows the shining lode down into the foundation granite, where the mineral vein, instead of lying flat, or nearly so, like a bed of coal, shoots almost vertically towards the centre of the earth, and its value to man for ever, is bounded only by his power to follow it, and the expense of raising it to the surface. It is there that we find shafts of really magnificent depth. *Fresaveen Copper mine is* 2,112 *feet below the surface, and* 1,700 *below the level of the sea.*

SHAFTS IN THE ANTHRACITE REGION OF SOUTH WALES.

In this, the most considerable Anthracite Region of Europe, *shafts* are neither so frequent nor of such great depth as in the bituminous districts of Wales, and throughout the kingdom. The beds of coal, inclined at a dip of 9 to 12 inches in the yard, or nearly 1 in 3, are worked out chiefly by *levels*, often in *slopes* as in Schuylkill County, and only occasionally by perpendicular shafts. These however, where not necessary for raising the coal, are frequently sunk for purposes of ventilation.

The rocks consist of shale, hard sandstone, mixed ground, fireclay, and what are known, locally, as "cliff" and "ward." Interspersed with these, the veins and balls of ironstone are remarkably abundant, and the beds of coal though not averaging—with the exception of one called the "18 feet vein"—more than perhaps 3 feet in thickness, are numerous and close together. A section at Yniscedwin, discloses 20 beds of anthracite; 64 feet thickness altogether, in a vertical reach of strata of 450 yards.

None of the collieries in this region have been very long opened, and as

anthracite coal has hardly yet succeeded in forcing its way into favor in Great Britain, the mines of that invaluable fuel in South Wales have none of them, as yet, reached a very great extent. The deepest pit in the district is not perhaps over 600 feet from the surface.

Let us now proceed to inquire at what cost shafts are sunk in this region, which, containing as it does a much larger area of anthracite coal than exists in our country (however backward in comparison the English operators may have proved in its development), must always be possessed of great interest to Pennsylvanians.

At Yniscedwin, (the scene of the experiments of *Crane*, to whom is generally conceded the praise of being the first to use anthracite with success in the manufacture of iron,) the veins of the *Entre-ladis Colliery* are reached by "level," one and a half miles long. This level communicates to the surface some distance in, by a shaft 240 feet deep, and 15 feet by 10 in diameter.

The shaft I was told, cost about $8 25 per foot of depth for sinking alone.

At Ystilifera, in the same vicinity, two shafts were being sunk at the time of my visit, to a 4 feet seam of anthracite, 90 feet from the surface. One of these shafts, a hundred and twenty yards distant from the other, was intended for an *upcast*, and will be used exclusively for the air and for pumping. It is only 6 feet in diameter, while the *downcast* shaft is 12—an arrangement that is by no means *philosophical*, as the passage for the return air should invariably be greater than that for the fresh air.

To win out the shaft and free it from water during the progress of the sinking, an engine of 25 horse power was erected, *with* which they expect to "wind" 100 tons of coal daily, on the completion of the works, and do the pumping in the night. The shaft is *walled* with stone and brick, two and one-half feet in thickness; the brick is a course of 9 inches, lining the stone-work towards the shaft, and the wall is raised 15 feet above the ground to allow for the *tip*.

This shaft, 12 feet in diameter and 90 feet in depth, will cost, when finished, about $5 00 per foot, or nearly $500 in all.

A short distance below Ystilifera, in the same Swansea-Vale, a new shaft was being sunk 600 feet in depth, to the "Red Vein" of anthracite, a yard thick. It is of elliptical shape, 14 feet long and 9 wide, and was expected to cost $10 per foot, or $6000 for the shaft.

In the valley of "Cwm-Tyrch," near Yniscedwin, at the colliery of Messrs. Swan & Brothers, the agent told me, the expense, including walling with brick, of a shaft 6 feet in diameter and 400 feet in depth, was about $5 00 per foot.

The *Ystilifera Coal mine*, one of those from which is drawn the supply of fuel for the 11 anthracite furnaces of the Ystilifera Iron Company, is 480 feet in depth. The pumping arrangements here are worthy of notice. The pumps are in two lifts. The first, 10 inches diameter, extends 180 feet down to a sump or reservoir, where the other, 8 inches in diameter, commences and extends 300 feet lower to the bottom. The "buckets" are 6 inches long, and the iron rod which works the bottom one, 300 feet in length, is an inch and a half thick. The "water level" at the bottom, 480 feet from ground, is 6 feet high and 6 wide, being driven at this time to a length of about a fourth of a mile. The engine performing the winding and pumping, is one of 30 horse power; the latter part of its duty is performed at night or when off work.

This shaft, 8 feet by 10 wide and 480 feet deep, cost about $10 per foot for sinking alone.

At "Waters' Colliery" in the same vicinity—the shaft of a newly opened mine—was 10 by 13 feet in diameter and 570 feet deep. The *cost* was $10 to $11 per foot for sinking. The walling was of brick 9 inches wide, and the cost for building alone 62½ cents per perch. This, with the cost of the bricks and other expenses connected with the work, would amount to rather over $2 00 per foot of depth, for a wall of this nature and circumference.

In sinking, the wall is built on iron curbs which encircle the shaft at convenient depths, and until the solid rock is met, are suspended by iron rods

from the surface. In going down, the wall is thus carried on with the sinkers. It is supported on these curbs, which are of the L shape, (the upright of the L being 3 inches and the base 2 inches,) and occur at intervals of about 12 feet vertical. On reaching the solid rock, a *curb* is inserted on it, and the wall built up to meet the next curb above.

The cost of sinking shafts in this part of South Wales, observed to me the Mining Engineer at Yniscedwin, is variable, and depends on the water and other conditions, but it may be taken at an average of $8 00 or $10 00 *per foot for the excavation alone;* the masonry or walling is usually 2 feet thick, and of stone. It is done at the rate of $4 00 per cubic yard.

W. J. P.

THE WARD COAL AND IRON COMPANY. BY PROFESSOR JAMES HALL.

[Continued from page 496, Vol. VII.]

Brick Earth or Clay for Common Building Bricks.—The most extensive deposit of this kind seen upon the estate, lies in the valley of the north branch of Jennings' Creek, a short distance below the brick works, and very accessible for working. It appears to be formed in part by the decomposition and mingling of the shale and fire clay above the Parker coal seam. The material is abundant, and forms bricks of an excellent quality. The manufacture of common bricks may be made a very profitable business at this place, since there is a good demand for them in Cumberland; and you have here all the advantages of proximity to market, with cheapness and abundance of material and of fuel.

Iron Ores.—Iron ores were observed at numerous points on the estate; the places having, for the most part, been opened only sufficiently to test the quality and thickness of the bed, no large quantities had been extracted except at a single point.

Thirty or forty feet below the conglomerate there is a bed of ore, said to be two feet thick, and called here the Lycoming ore. This ore is a hematite of good quality, and may be readily mined along the eastern outcrop of the measures. Twenty-five feet above this occurs a layer of nodules or concretions of carbonate of iron, which lies beneath the lower bed of fire clay.

Beneath the Bluebough and Parker coal beds, lying above the fire clay, is a bed of iron ore, known as the Mammoth ore, having a thickness of two feet. The bed appears to have been originally an argillaceous carbonate of iron (iron-stone), in nodular masses, shaly matter filling the interstices.

The exposed outcrop presents the ore in the form of an earthy hydrated peroxide, or hematite ore.

About thirty feet above the Parker coal seam, the thick mass of fire clay and shale, (before noticed,) contains four distinct strata of argillaceous carbonate of iron, lying in detached nodular masses. On the exposed outcrop this ore is converted into a peroxide of iron. The four layers together constitute from two and a half to three feet of ore. The clay embracing this ore will no doubt be found available in the manufacture of bricks; and in the process of quarrying or mining the rock, the iron ore will be separated.

On Jonsie's Run, a bed of iron-stone has been opened, said to be two feet thick. The ore upon the surface is in nodules from six to eight inches in diameter. The excavation had not been sufficient to penetrate beyond the out crop; and I am unable, from personal inspection, to speak of the thickness of the bed. The ore will, however, doubtless become available in the manufacture of iron, when a furnace is established upon the estate.

On the brow of the hill, upon the west side of the north fork, there is a very prominent outcrop of iron ore known as the Stone House ore. It is a peroxide or hematite, lying in two or three bands, and having a thickness of about two feet. This ore was wrought at one time, and several hundred tons of ore have been taken out. Some of the ore still lies in heaps at the openings from which it was taken. The old openings are mostly filled up with

earth. The appearance and quality of this ore are very good, and the bed will doubtless prove a very valuable one, in furnishing a supply of iron ore for a furnace.

Its outcrop, on the face of the hill, renders it very accessible, and when once brought to the surface, it would be within a few rods of the proper points for the establishment of a furnace, thus costing comparatively nothing for transportation. The same would be true of the beds of iron-stone above the Parker coal, and which crop at the level of the road near the proper furnace site.

Still further westward, and at least one hundred feet higher than the Stone House ore, an opening has been made upon the outcrop of a bed of ore. It occurs in small nodules of the peroxide, distributed through two feet of clay. No rock has yet been reached, though the regularity of the layers indicates the proximity of the rock in the place.*

At a point one mile north of the village of Barrallville, there is an outcrop of iron near the top of the hill, and dipping towards the valley. The ore is a very fine hematite, and free from earthy admixture. This bed is said, by the person who opened it, to be three feet thick.

At the time of my examination the opening was filled up by the falling in of the superincumbent earth. Several hundred pounds of the ore lie at the place; and large pieces are seen on the hill side, which have been removed from the outcrop of the bed by natural causes. These facts indicate a continuous bed of ore, and one which is of sufficient magnitude to be relied upon for furnishing a considerable share of the supply required by an iron furnace.

The outcrop of another bed is known still further to the northward, but I saw only specimens of the ore; these are dark colored, earthy and fossiliferous.

Bog ore occurs at several points, but the deposits have not been sufficiently opened to determine the probable quantity.

The indications of an abundance of iron ore are as favorable as could be desired. The tract embraces the lower beds of the coal measures, which are in other places prolific in the production of iron ores.

Limestone.—There is a bed of limestone, some fifteen or twenty feet thick, lying among the red shales and sandstones below the coal measures. It is exposed at Jennings' Creek, nearly a mile below the village of Barrallville. The stone was formerly quarried for the Mt. Savage furnace, and considerable quantities have been taken from the face of the hill.

A bed of limestone, five feet thick, exists on the hill north-east of the village. Limestone of the lower geological formations occurs in abundance between Barrallville and Cumberland, so that there are available sources both for a flux and for burning into lime in the immediate vicinity.

I have given above an enumeration of the mineral products of the State, and incidentally of its valuable timber. This estate possesses one of the first requisites for a profitable coal-mining property; and by judicious cutting, the growth of the young timber will not only supply the wants of the property, but will prove a source of revenue to the company.

Your company have already a steam saw-mill in operation; and the estate is capable of furnishing a large quantity of timber, if thought expedient to prepare it for market. Nevertheless, in view of the development of the mineral resources, it would be wiser to withhold this from market for the present, as large quantities will be required in the mines, and also for the erection of buildings upon the estate. The improvements already made upon the

*There is also a bed of plate ore, twelve inches thick, and four feet above it a bed of pin ore eighteen inches thick. Both of these are valuable ores, and may be worked together to advantage. Their outcrop is within a few rods of the locality suggested for your furnace.

There is also a bed of ore, two feet thick, discovered directly above the fourteen feet bed of fire clay. This may prove of great importance and value, being also near the furnace locality.

estate have been constructed for durability, and are at present in very complete order.

The next point for consideration is the availability of these products, either for manufacture or for market, in their raw state. As the preparations for the manfacture of fire-bricks are already nearly completed, I will, therefore, introduce this subject first in order.

Brick Works and Fire-bricks.—The brick works erected, and in process of erection, are intended to be of the most substantial kind.

The brick machine is now nearly ready to go into operation, and the entire works, including the mills for crushing the clay, and machine for priming, &c., will be in order by the 1st of November. This machine is capable of pressing and delivering 20,000 bricks daily. It is equally adapted for the manufacture of fire-bricks, or of common building bricks, though intended mainly for fire-bricks. The machine is erected in connection with the steam saw-mill, as also the crushing machine, so that one engine will move the whole.* The drying and burning kilns are in close proximity. These are situated a few rods above the coal openings, and near the continuation of the railroad track; so that the coal can be taken to the kilns on the same cars in which it comes from the mines. The fire clay is now brought from the hill half a mile distant; but, as before mentioned, is accessible from the same point as the lower coal seam, and can, in either case, be delivered at the kilns at a trifling cost. The great thickness of this bed (the fourteen feet bed, described on page 496., vol 7), will always of itself furnish a sufficient supply.

Cost of Manufacturing Fire-Bricks.—In calculating the cost of manufacture, every care has been taken to include all possible expenses, and to this estimate one third more has been added; and assuming the manufacture of 10,000 bricks daily, being one-half the capacity of the machine, these bricks can be made for eight dollars per thousand. The price in market is from thirty to thirty-five dollars per thousand. Large quantities are at present manufactured at the Mt. Savage works, and these find a market in Baltimore, New York, and even in Wheeling—being highly prized for their superior quality. Your company has a bed of superior fire clay, more advantageously situated for mining, and with one tenth the distance of transportation, while your kilns are situated almost at the mouths of your coal mines.

The demand for fire-bricks must increase in proportion to the manufacture of iron and the progress of other collateral branches of industry; and it is scarcely necessary to give statistics to prove that there is an active and rapidly increasing demand for fire-bricks of good quality.

After making all allowance for cost of transportation, commissions, &c., it seems scarcely possible to reduce the profits in the manufacture of fire-bricks so low as ten dollars per thousand. The manufacture of this article alone, therefore, if judiciously carried on, is sufficient to pay a handsome interest upon the valuation of the estate.

Common Bricks, and Cost of Manufacture.—I have already noticed an extensive deposit of common brick earth or clay near the brick works. The manufacture of these bricks might well be added to the other industrial enterprises of your company.

At the present time, the most common building bricks are sold, in Cumberland, at six dollars per thousand, and pressed bricks would be worth, probably, eight dollars. Estimating the product of the machine, daily, at 10,000 bricks (20,000 being its full capacity), they can be manufactured at the cost of one dollar and fifty cents per thousand; and making allowances for unforeseen contingencies, we may say two dollars per thousand as the extreme cost of bricks delivered in the cars upon the railroad track.

* Your brick machine, the patent for which, for use in the entire Cumberland Basin, is owned by your Company, is a machine simple and perfect in its construction, and manufactures a superior quality of bricks with rapidity and perfection. The ownership of the patent must give you the monopoly of the brick manufacture in the Cumberland region.

It appears to me that considerations of economy and ultimate profit should your company to establish this manufacture in connection with that of fire-bricks.

Iron Ores and the Manufacture of Iron.—The quantity of iron ore presented in the outcrops of the several beds, would appear to be sufficient to warrant the establishment of an iron furnace upon the estate.

The proper position for the location of a furnace would be in the valley of the stream, below the steam saw-mill and brick works, and in convenient proximity to the coal openings. It would likewise be near the outcrop of the Stone House ore bed, from which a large supply of ore would be derived. This is likewise in close proximity to the shales and clays, the beds of ironstone above the Parker coal bed, and to the Mammoth ore which lies between the Parker and the Bluebough coal beds.

In locating the furnace, care should be taken to have sufficient space in the valley below it, for the future location of rolling-mills, and other works connected with the manufacture of iron.

The limestone, already mentioned, is distant about one mile from this point, while all other materials are in the immediate vicinity of the point recommended.

Although there would appear to be an ample supply of ores upon the ground, yet any furnace established here would not be dependent upon these ores alone; since at the distance of five or six miles below, on the road to Cumberland, the fossiliferous ores of the Clinton group, and of the Oriskany sandstone, are mined to a considerable extent, and are largely used in the Mount Savage furnace.

The formations containing these ores occur also much nearer to Barrallville, that is, between Barrallville and the westerly face of Will's Mountain, and the iron ores should be sought for near the eastern limits of your estate. Should the same beds be found here, occurring, as they do, nearer to Cumberland, in the Clinton group and Oriskany sandstone, you will have a supply of the fossiliferous ores, within two or three miles of your furnace.

It may also be found, that an admixture of the ores of the coal formation with those of the rocks below, will make a better iron than either of the ores alone.

The general quality of your ores is already well known. The ironstone or carbonate of iron, may be rated at from 30 to 35 per cent., while the hematites, or peroxide of iron will yield from 40 to 55 per cent., according to their greater or less purity.

These all being ores well known, and which are already worked in the neighborhood of your estate, the time and expense of a careful analysis seems unnecessary.

Before, however, proceeding to the erection of a furnace, I would recommend a careful testing of the beds of ore indicated, both as to their yield per square yard and as to the persistence of the beds. This may be done at a very moderate expense, and in most cases the ore obtained will repay the expenses. Thus there is little or no risk of loss by adopting such a course, while it insures a certainty in the results that will be eminently satisfactory to all concerned.

By proceeding judiciously in the examination and proving of the different ore beds, your company will be prepared, at the end of six months or a year, to determine the supply of ore to be derived from their own property; and also the cost at which the lower fossiliferous ores can be supplied at their furnace.

It may here be worthy of mention that the iron furnace of the Union Iron Company, at Wellersburgh, two miles north of Barrallville, is supplied with ores similar to those on the estate of your company; and some of them probably from the same beds as here indicated. This furnace, as I was informed on the ground, is run with these ores alone, the lower fossiliferous ores not being brought to this place.* So long as the manufacture of pig iron alone is

* The Union Coal and Iron Company's Works are located two miles north of your works

contemplated, it is not probable that any other ores, except those on the estate, will be required; but should it be determined to extend the manufacture, and convert the pig iron into bars of different kinds, it will then doubtless be found advisable to mix a certain proportion of the other ores.

Although satisfied of the feasibility of the plan of erecting an iron furnace on this estate, I would, nevertheless, advise a postponement of a few months, not only for the purpose of thoroughly testing these ore beds, but also to give time for bringing to perfection your manufactory of fire-bricks, which will soon become an important source of revenue. By this course your agent and manager will have ample time to make his arrangements for accomplishing the undertaking in a more satisfactory and economical manner, while he will not be burdened with too many cares and anxieties at the same time.

Mining and Transportation of Coal.—Should your company erect an iron furnace and the collateral works, a large demand will be created for the coal beds adjacent. In the drying and burning of fire-bricks, and in the burning of common bricks, there will be consumed more than two thousand tons per annum; and upon the establishment of an iron furnace, a much larger amount will be required for that object.

Before undertaking the mining of coal as a business of the company, I would recommend that both the iron and the fire-brick manufactures should be brought to perfection. Much of the fine or waste coal of the mines may be consumed in these operations, and particularly by coking in ovens (already erected upon the place). The waste coal is applicable for the iron furnace. Thus there would be no loss of coal, and the mining of coal may be advantageously carried on in connection with other branches, and rendered more profitable than if undertaken as the entire or principal business of your company.

The statistics of the cost of coal mining and of coal transportation are within the reach of every one, and it is scarcely necessary to repeat them here. The cost of mining coal may vary according to the thickness of the bed, or character of the ground, or facilities of transport from the mine, from 40 to 50 cents per ton, The beds of coal upon this estate, though not so thick as some others, are very favorably situated for removing the coal, as before explained. Still it may be safe to estimate the cost of mining at 50 cents per ton; and to this cost is to be added the cost of freight and charges.

In considering this part of the subject, it should not be forgotten that two of these coal beds opened cannot be rated above three feet in thickness each; and in mining these there will be nearly the same amount of waste or fine coal as in beds of twice the thickness. It will be wise, therefore, to provide some means of converting this waste coal to economical use, and the plan recommended meets that requirement. Nevertheless, in estimating the cost of mining and sending to market the coals from the Bluebough and Parker beds, the greater expense of mining from these than from a six-foot bed, is compensated by the less cost of transportation to Cumberland, the distance being only seven miles, while all the other mines which now transport coal to Cumberland are at distances from twelve to thirty miles.

According to this estimate, we have, per ton—

For mining and delivering into cars on the railroad	$0 60
Transportation to Cumberland, at 4 cents per ton, per mile	28
From Cumberland to Baltimore	2 75
	$3 63
By the Chesapeake and Ohio Canal this cost may be reduced by 90 cents	$2 73

The branch railroad is already in existence, and requires to be kept in repair equally for a small or a large business.

That company manufactures pig iron only, producing from 70 to 100 tons per week, at a cost not exceeding $15 per ton. They informed me that they had, under contract, disposed of all the iron they had manufactured this season at $25 per ton.

Your company can manufacture at your works pig iron at a cost not exceeding $15 per ton, and of a quality equal or superior to that made by the Union Iron Company.

Coal is to be mined for the business of bricks, and ultimately for the manufacture of iron; and by extracting a much greater amount than will be required for consumption on the estate, it may be done at a proportionably less rate, and the cost on that consumed will be lessened, as well as upon that portion sent to market.

At the present rate of charge on the transportation of coal, I would express the opinion that this branch of the business should not be undertaken alone, nor until after the others are fully matured and in successful operation.

I have already alluded to the position of the village, with reference to the coal openings, the saw-mill and brick works, and to the proper site for a furnace. The advantages resulting from the concentration of all the various branches of business which the company may decide to prosecute in close proximity to the abodes of the operators, must be obvious to every practical mind. The small cost of mining, and the trifling expense of transportation of coals, iron ores, clays, &c., from the mines to the works, give the company unequalled advantages. Again, the railroad facilities by which railroad cars destined for Baltimore or Wheeling, or for the Chesapeake and Ohio Canal, may be loaded at the coal mines, brick kilns and at the iron furnace, thus avoiding the necessity of teams, cannot be excelled by any other establishment.

Your position being such that you have ready access to every market in the Union, must ever secure to you a market for your manufactures; and having the advantage of cheapness and quality in your favor, you need have no fear of competition from any point. Fuel enters largely into the cost of the manufacture of both iron and bricks, and your coal mines will always furnish a superior article at your furnaces and brick-kilns at a cost not exceeding 75 cents per ton.

Your limestones and clays can be delivered at the furnace and brick-kilns at a cost of less than one dollar per ton, and the iron ores at a cost not much beyond this price.

The estate of your company contains ample mineral resources for the profitable prosecution of the several kinds of business named; and by a judicious management of its affairs, cannot fail to bring satisfactory results.

IRON AND ZINC.

THE PRODUCTION OF IRON IN THE UNITED STATES.

The last annual report of the Secretary of the Treasury contains the following remarks:

"Iron and steel being articles of general use, in all our States and territories, and necessary in the prosecution of all industrial pursuits, the annual consumption and the annual home production and import, become a matter of solicitude with many, and of interest to all. It appears from the census of 1840, that we produced and manufactured iron and steel, that year, to the amount of $29,909,162, and that we imported iron and steel, and the manufactures of iron and steel, to the amount of $7,088,739, and exported iron and steel, and the manufactures of iron and steel, to the amount of $1,104,445, leaving for consumption $35,893,446; and, from the census of 1850, that we produced and manufactured iron and steed that year, to the amount of $60,485,653, and that we imported iron and steel, and the manufactures of iron and

steel to the amount of $17,524,459, and exported iron and steel, and the manufactures of iron and steel, to the amount of $1,911,320; leaving for the consumption of the year, $76,198,792. The same ratio of increase in the production and manufacture of iron and steel, from 1850 to 1855, as found to exist between the years of 1840 and 1850, gives the production and manufactures of iron and steel for 1855 at $78,406,538. To this add $23,945,274, for the amount of the imports of iron and steel, for the year 1855, first deducting the export of those articles, and there is iron and steel, and the manufactures of iron and steel, to the amount of $98,598,340, for the consumption of the year. The estimate of $78,406,538 for the year 1855 is, no doubt, some ten or fifteen millions less than the production.

A comparison of the population of 1840, with the production and manufacture, import, export and consumption of iron and steel, and manufactures of iron and steel, and the like comparison of the population of 1850, with the production and manufacture, import, export and consumption of those articles in 1850, extended by estimate for the production and manufacture in 1855, and by the import and export and amount left for consumption of that year, places the subject fairly before us, in connection with our past and future supplies and future wants. The table of prices at Boston, New York, Philadelphia and Baltimore, for the last seventeen years, furnishes the fluctuations in the prices of bar iron, and a criterion for the value of the other descriptions, and proves that this indispensable article, like all others, obeys the laws of demand and supply, in affecting the profits of the producer and manufacturer, operating favorably or unfavorably, upon the amount prepared for general use.

We have in the United States more iron ore and more coal, with the usual fluxes, in convenient connection and of cheaper access, than all the other civilized nations of the world, and have the necessary capital, skill and labor to produce all the iron and steel, required for our consumption, for centuries to come, and also to enable us to supply the markets of other countries, in fair competition with the iron and steel of other nations. These tables show that our production of iron and steel, and the manufactures of iron and steel, was greater in proportion to population, in 1850, than it was in 1840, and that it was greater in 1855, than it was in 1850, giving us the right to assume that, influenced by the same causes, it will be greater in 1860 than it now is, and in time will be sufficient for our own consumption and then give us a surplus for export. But taking into consideration our present population, and accumulated capital, with the amount of capital annually drawn from other countries, in the course of emigration, and the great cost of carriage to the interior of our country, with the late improvements, in the modes of production and manufacture of iron and steel, it would not be rash to expect a full supply for our own consumption between this and the returns of the census of 1870.

The tax upon iron and steel, and the manufactures thereof, because of their general use, in all sections and in all industrial pursuits, has been considered as equitable and fair a tax, as it was possible to impose upon the country; consequently no material change has been contemplated or recommended; but if continued at present rates, it is not supposed the same amount of revenue will be derived from it, even should the use of iron, as no doubt it will, be extended to many other purposes, and be consumed in much greater quantities. In commercial intercourse with nations, based upon equivalent exchanges, as it must always be, if profitable and continuous, we may look forward to the time when we shall produce, within our own limits, all articles that are essential to national defence and the use and comfort of our own people; and of these there is none more necessary to the defence of the country and the use and comfort of the people, and of which we have better means of producing in the country, than iron and steel, and the manufactures of iron and steel. Yet the production should not be stimulated, by unequal and unjust taxation, nor the period of an abundant supply, from our mines and factories, retarded by impolitic legislation. The home production of iron, and the manufactures of iron

and steel, is on the increase. The tables prove the production and manufacture of these articles have increased with our increased population, and that we import less, in proportion to our population and consumption, than formerly.

Under a conviction that we were collecting, under the existing tariff, more revenue than the at present economical administration of the Government, and a wise and prudent outlay for the future, made necessary or called for, and also under the conviction that an overflowing treasury would induce wasteful and extravagant expenditures, a modification of the tariff of 1846, and a reduction of the revenue from customs, was suggested in my first report on the finances, and renewed in both my subsequent reports, and is now again reported, with, if possible, a firmer conviction of its necessity and propriety, and for the same reasons and others that could be named.

FRANKLINITE ORE BEDS.

The Newburg, (N. Y.) *Gazette*, speaking of the Franklinite mines, says: "That they learn that arrangements are on foot for the establishment at that place of one of the most extensive iron works in this country. The sagacious men who are at the head of this enterprise, foresee that the time is not far distant when the coal road to the river Delaware will be built, and from that moment, as we have often said, Newburg will begin to be the great central point of the iron and zinc manufacture of the United States." The railroad alluded to, is the Sussex and Warren, which is intended to unite with the Newburg branch of the Erie at Chester, and from thence running through the mineral region of Sussex county till it strikes the Delaware, and tapping the coal road to Scranton. This road will add immensely to the value of real estate at Newburg, transporting about 500,000 tons of coal from the coal fields of Pennsylvania, and 200,000 tons Franklinite zinc and magnetic iron ores, which are in great abundance in the neighborhood of Franklin. It costs the New Jersey Zinc Company for transportation via the Morris Canal nearly $60,000 per annum; by this route the same quantity of ore could be landed at Newark for $20,000.

BLACK BAND IRON ORE.

A correspondent of the Philadelphia *Ledger* describes recent discoveries of the above famous ore in McKean Co., Pa.

"Black Band iron ore is found in Scotland, and has obtained celebrity for the peculiar quality of the metal it produces. It makes iron which is much more fluid when molten than any other, and therefore it makes castings much finer, and with less weight of metal.

The closest search has been made for it in America—but up to the month of October of this year, had not been found of such extent and quality as to be worthy of remark.

But in October, 1856, Profs. Owen, of Indiana, and Newham, of Lackawanna, while examining the new bituminous coal in McKean county, Penn., discovered the regular seam of this most valuable mineral, forming the roof of a five-foot vein of cannel coal, and giving undoubted evidence that it covers a great portion of that coal field. They suspected that some of the slates of the coal veins might be saturated with iron, because in no part of our State is limestone of other varieties so plentiful as in McKean county. The vein is five feet thick, and one branch of it, eighteen inches in thickness, yields, by the analysis, 43 1-2 per cent. of iron."

RAILWAY AXLES.

An invention by M. Aerts, for preventing railway accidents occasioned by the fracturing of axletrees, is reported to be receiving much attention in Belgium. The improvement is said to be so favorably regarded by the Belgian

Government, that they are about to adopt it on their lines. The following is a description of the invention, and the mode of procedure of the inventor in arriving at the conclusions which it embodies.

M. Aerts, in order to find out a proper remedy for the evil, had first made a searching inquiry into the causes which produced it. He ascertained that every axletree, whether by its heavy wear and tear, or by the peculiar quality of the iron, will inevitably break at the end of a certain time, more or less long, in consequence of the continual "torsions" which it meets with in the progress of the train over curves. As each pair of wheels is connected with the same axletree, and one cannot turn without the other, it must necessarily happen that in curves the wheels which turn upon the exterior rail, having a greater revolution to make, must make a greater number of turns than those which revolve upon the interior rails; and, as their movements are of a peculiar character, they cause a sliding motion, which occasions "torsions" more or less severe, according to the weight of the carriage itself, or the pressure caused by the wheels upon the rails.

M. Aerts having minutely examined a number of broken axletrees, had perceived that each of them, before becoming a complete fracture, must have exhibited premonitory symptoms for one or two years before. The "torsions" of those axletrees, at the end of a given time, occasion the breaking of some splinters of the iron at the place where the axletree is the least strong; generally about the middle of the wheel a slight crack takes place, which the wet and the dirt so concealed as to escape the eye of the most careful inspector. Believing that it is impossible to avoid the breaking of axletrees, the inventor applied his mind to discover some means to prevent those terrible accidents which occasionally result from such fractures. Those means appear to be as simple as as they are ingenious.

He lengthens evenly the interior nave of the wheel from five to six centimetres, and above each of them he places a plate of metal, securely and solidly fixed to the train. These plates of metal have the shape of a horseshoe, while they tend to prevent any accident from the causes to which we have referred, they occasion no friction against the naves of the wheel, from which they are distant from seven to eight millimetres; and even should an axletree break, those plates of metal will support the carriage in its proper position, and keep the wools in their ordinary place so accurately, that the train will continue its speed, and the wheels will proceed in their right position, without the travellers being at all warned of the accident that had just taken place. At the end of a few moments, in consequence of the friction produced by the plates coming in contact with a part not greased, a slight hissing noise will be heard, which will be sufficient to intimate that an anxletree has broken. At the first station the particular carriage may be withdrawn from the train, which can still proceed to its destination as if nothing of the kind had happened. Besides this guarantee against danger, M. Aerts offers another, which, when joined to the former, will be found most efficacious—it is, that the carriages shall each rest on six wheels.

This invention has been tested on the Antwerp Railway during the last eight or ten months, and has been found to work admirably.

AN IRON WORKS JUBILEE.

The Phœnix Iron Company at Phœnixville, Chester County, Pennsylvania, having carried their production of rolled iron up to 1732 tons in a single week, it was determined to celebrate its success with a grand festival of the workmen, and it would be difficult to name a victory better worth celebrating in such way than this success in the most important manufacture of the country. The Jubilee came off on the 6th ult., and was attended, the West Chester *Village Record* says, by 624 persons. From the correspondence read

on that occasion, we extract the following from the letter of Samuel J. Reeves, Esq., Treasurer Phœnix Iron Company:—

I find in analyzing the week's report sent to me from the work, that eight furnaces heated 3,354 rail piles, and produced 3,324 perfect rails; that is, all were first quality except 30, and of these 15 were second quality; 3 made 6 1-2 inch covers, leaving only 12 actually condemned.

Of the 3,324 perfect rails, all were full length—viz., 24 feet each, except 71, making only 21 short rails in each 1000 produced.

The average length of all the short rails was 20 feet 9 1-2 inches.

The average length of all the rails was 23 feet 11 1-6 inches. Nearly every furnace heated 420 piles in the week, making 84 heats of 5 piles each. The gross product of the piles weighed 832.86 tons, producing 1st quality 62 lb. and 60 lb. rails—732.76; leaving 100.10 tons, consisting of 2d quality rails, 6 1-2 inch covers, and crop ends of rails.

By an inspection of the above results, it will be seen, that considering the rolls had to be changed to make two patterns of rails, and that only the ordinary force of the mill was engaged upon the work, and that all was finished on the Saturday afternoon by 3 o'clock, it is the largest product of finished rails ever made in one week in any establishment in this country, and I confidently believe it never was exceeded by any establishment in England, working the same number of furnaces.

The work in the Puddling Mills was also, I think, the largest ever produced at any establishment in this country, amounting to 608.76 tons of bar, and the work in the North and East Mill amounting to 388.26 tons of Nos. 2 and 3 mill bar, and a variety of merchant iron, was equally extraordinary.

STRENGTH OF WROUGHT AND CAST IRON.

A paper "On the Laws of the Strength of Wrought and Cast Iron," by William Bell, from the Institution of Civil Engineers, Dec. 9, of which the London *Engineer* gives the following abstract:

In this paper it was stated that the chief point had been the consideration of the longitudinal, as compared with the transverse, strength of wrought and cast iron. For this purpose, the whole of the experiments made up to the present time, on tearing asunder, or crushing bars of cast-iron, and those made by breaking bars transversely, had been taken, and from them, and the known formulæ of elasticity, such values of the constants in the formulæ had been deduced, as would satisfy each experiment individually. And by comparison, a general view of the accordance or non-accordance of theory with experiment had been obtained, and some general laws arrived at.

The mathematical theory of elasticity, as given by Poisson and Navier, was assumed. By finding, for each experimental beam, the centre of gravity of the area of cross section, through which, according to this theory, the neutral axis passed, and calculating the moment of the forces with respect to this axis, the application of the formulæ to the experiments was easily made.

The first constant obtained was the weight per square inch of the modulus of elasticity, and this, when deduced from the transverse strain, was taken from the deflexions produced by small weights, and in all cases where the beam or bar was very little strained. For wrought iron, the most comparable experiments were considered to be those detailed in the "Iron Commissioner's Report," which gave by transverse strain from 12,200 tons to 12,750 tons per square inch, and by extension of bars from 12,200 tons to 12,900 tons per square inch. For cast-iron, the averages of Low Moor, Blaenavon, and Cartsherrie irons were, from tension, 6,305 tons, for compression, 5,698 tons, and from transverse strain, 5,968 tons per square inch. Other experiments on the transverse strain of wrought iron gave from 9,000 to 14,000 tons per

square inch; whilst with cast iron the results were found to vary from 4,000 to 8,000 tons. On this point, it was stated, that Mr. W. H. Barlow, F. R. S. M. Inst. C. E., in some experiments on the neutral axis, recently laid before the Royal Society, found results nearly agreeing with the higher number.

Another mode of arriving at the value of the modulus of elasticity, by means of the bending or breaking weight of "long pillars," was also examined; the ratios of the lengths of the pillars to their diameter being taken as abscissæ, and the bending weights, obtained from both theory and experiments, as ordinates, it was thus found that, for the experiments on wrought iron pillars, given in the before-mentioned report, the curve of theory agreed very well with the curve of observation, until the length became shorter than 70 times the thickness. The experiments on cast iron pillars examined were those in the second volume of Tredgold on Cast Iron. The correspondence with theory was very good for those with the ends rounded, until the length became shorter than 20 times the diameter; and for those with the ends flat, until the length became shorter than 50 times the diameter. The hollow cylindrical pillars, with one exception—that of a short pillar—gave values for the modulus of elasticity of from 4,350 to 6,680 tons. The correspondence between theory and experiment seemed, in the author's opinion, to warrant the conclusion, that the theory was perfectly trustworthy when only small compressions and extensions were concerned.

The fundamental assumptions usually made in the theory of the strength of materials were then considered. First, that in a beam strained transversely, the extensions and compressions of the particles were proportional to their distances from the neutral axis. Second, that the extensions and compressions were proportional to the tensile and compressive forces, known as Hooke's law, and by the phrase, *ut tensio, sic vis.* And third, supposing the latter law to hold good, that whenever, in a beam subjected to transverse strain, the tension or compression on the outside particles was the same as would be obtained by direct experiment on pulling asunder or crushing bars of the same material, the beam gave way. It appeared, however, from experiment, that for large compressions and extensions, the law of Hooke ceased to be applicable. It was found that, in cast iron, this law did not differ widely from the truth within the range of the experiments; whilst in wrought iron, although the difference was great near the point of rupture, yet the curve of compression was similar in form to the curve of extension, the ordinate likewise being nearly equal in amount. The true law might, therefore, be roughly expressed by saying that, beyond a given amount of force, the same force corresponded to all compressions and extensions, this force being nearly the force of rupture, either by longitudinal compression or extension: in other words, the force was scarcely altered by a large increase of the compression or extension. It was next considered what effect this deviation from the law of Hooke would have, as to the force on the outside particles, as deduced from that law; the supposition being made that the force was constant, and therefore equal to the force of rupture for all compressions or extensions. From this investigation the author thought it would be obvious that the supposition of a constant force was different from the truth in one direction, while the law of Hooke was different from it in another, so that these two laws formed limits between which the truth always lay; in cast iron, the latter law being more nearly approximated to. It was shown that the results derived from experiments, by assuming the ordinary law, were slightly above the truth, the difference, even in a rectangular section of wrought iron, being probably less than 20 per cent., and in cast iron still smaller, while in large box and double T girders, with a broad bottom flange, the difference was practically insensible.

The other constant obtained was the value in tons per square inch of the tension and compression of the outside particles, when the beam became ruptured by transverse strain. For wrought iron the experiments on solid iron bars were fewer than could be wished, and gave results varying between 14 1-2 and 18 1-2 tons per square inch. In this material it was thought that

it might probably be the compressive, rather than the tensile force, which determined the fracture. The only experiments on the direct compression of wrought iron were those on two bars, given in the Iron Commissioners' Report—where one gave way under a strain of 14.5 tons, and another under 13.8 tons per square inch. The quality of iron was not stated, but it was believed to have been soft. It was asserted that the better kinds of wrought iron were able to sustain a greater tensile force, the worst kinds a greater compressive force. According to Mr. Eaton Hodgkinson's experiments, wrought iron might be defined to have its tensile to its compressive force nearly in a ratio of equality; cast iron to have those forces in a ratio of about 1 to 6. This being so, it was thought worthy of consideration, whether in the plates of a large wrought iron bridge subjected to compression, a slightly inferior quality of iron might be used, not only as more economical, but as better in itself.

With regard to riveted iron, the results from all the wrought iron tubes in the before-mentioned report, gave from 7.1 to 24.8 tons per square inch. The lower numbers were apparently caused by using thin plates for tubes of comparatively large diameter. If this were avoided, it was thought in calculating the strength of wrought iron tubes, 15 tons per square inch might be allowed for the breaking force on the outside particles.

When the experiments on cast iron were examined in this manner, the following fact became apparent: Experiments on small bars broken transversely gave results of 20 tons, and even more, for the tension and compression of the outside particles, when the experiments were examined by the ordinary theory. If these results were diminished by 20 per cent., which it appeared would more than make up the difference caused by assuming the ordinary law, there was still a result of, say 16 tons, while by direct experiments on the tensile force of cast iron, 7 or 8 tons was found to be the utmost that it would bear. In regard to this subject, Mr. W. H. Barlow had alluded to the alternative hypothesis that the neutral axis shifted its position as the beam became strained, and that when rupture took place the neutral axis was "at, or above, the top of the beam." This hypothesis was considered by the author to be contrary to the elementary principles of mechanics; for, as the sum of the compressive forces on one side of the axis, must be equal to the sum of tensile forces on the other, therefore, if there were tensions on one side of the axis, there must be an area out of which to get compressions sufficient to balance them on the other. As evidence on this point, in one material, the observations of Sir David Brewster in passing polarized light through a piece of glass subjected to transverse strain were alluded to.

In experiments on the direct tensile strength, it was assumed, that the outward force was uniformly distributed over the area of the bar; in other words, that the resultant of the external forces acting on the bar, passed through, and had the same direction with the axis. This probably obtained in wrought iron from its great extensibility before rupture; but in cast iron there was no such extensibility, and this point was, therefore, to some extent doubtful. If a few experiments were made, in which the force deviated from the axis by certain large and measurable amounts, and then were made to approach the axis, until some law was obtained which could be tested, this point would be set at rest. A table was then given showing the values of the forces on the outside particles at the time of rupture, in tons per square inch, from which it appeared that there was a diminution as the size of the beams increased. Beams 3 inches by three inches, as compared with those of 1 inch by 1 inch, shewing a falling off of strength to the extent of about 4 tons per square inch. The results derived from Mr. Hodgkinson's and Mr. T. Cubitt's experiments gave about 10 tons per square inch when the sound beams only of the latter experimenter were included in the calculation, or 9·6 tons per square inch when the unsound beams were taken into account. From this table it appeared that the breaking weight of tolerably large girders might be calculated with considerable accuracy by using 7 or eight tons per square inch as the force of tension on the outside particles when rupture took place.

In conclusion the author expressed the hope that he had succeeded in establishing the following propositions :—

First.—That in experiments where the materials were but slightly strained, theory and experiment coincided.

Second.—That where the ordinary theory was applied to the rupture of beams, and especially large beams, of wrought iron, theory and experiment practically coincided.

Third.—That there appeared to be no good reason for supposing that the neutral axis shifted its position, to an extent worth noticing, even up to the time of fracture.

Fourth.—That in cast iron, although theory seemed to differ from experiment, when the transverse strength of small bars was compared with the direct tensile strength, assuming the latter to be correctly stated at 7 or 8 tons per square inch, yet when the transverse strength of large girders was compared with the direct tensile strength, the coincidence of theory and experiment was nearly exact.

Fifth.—That the ordinary theory of the strength of materials was more trustworthy than was generally supposed.

In an appendix the author explained the formulæ used in examining the experiments, and gave the demonstration of the results arrived at.

MANUFACTURE OF MALLEABLE IRON, &c.—BESSEMER'S PROCESS.

(Continued from Vol. VII. p. 513.)

In the *London Artisan*, No. CLXIV., Sept. 1, are two large drawings of Bessemer's furnace, more highly finished, but similar to those given on p. 41, and an indorsement of the "simplicity and perfectly practical nature of the operation." On p. 206 is printed in full Mr. Bessemer's paper before the Association (given on p. 36), and on p. 208 a report of the discussion which ensued. Mr. Nasmyth being called upon by the President, stated three points of interest: first, that the iron presented, by Mr. Bessemer presented to his mind the most perfect and uniform appearance possible for iron to assume, with nothing of that laminated pie-crust structure so disliked by engineers and manufacturers; the saving of coals was the next matter of importance; finally, it was of the greatest importance that the manufacturer could get exactly the iron he wanted, and all of it alike. It is well known that the lapping or piling of wrought iron introduced innumerable plates of oxydated iron, or other impurities, between its layers, so that its strength is not an obtainable quantity; but this boiling of the iron reduces the whole immense mass to one consistency.

Mr. Wm. Clay, of Liverpool, responded, that in his opinion the greatest advantages were to be gained from the size of the masses of homogeneous metal obtained by this process, as compared with the small blooms of the past. Things now look possible which iron manufacturers have only dared to dream of heretofore. In making the great gun at the Mersey Forge, his views of the making up of iron in large masses had undergone a change; for now it is well seen that all striæ marks, seams, and fissures in wrought iron are plain indications of weakness. Bessemer's process will cure all this. But he presented another view: this process will enable the iron manfacturers to get rid of the most troublesome set of men with which any manufacturer was cursed, the puddlers, the real masters of the manufacturer and of the trade, who strangle the life, or at least limit and govern the production of wrought iron; and that not only voluntarily, but involuntarily, for the extreme strength and endurance of the strongest puddler is, of course, the extreme limit of the size of the bloom, beyond which the manufacturer of iron hitherto could not go.

Mr. Bud, of Ystelevera Works, in South Wales, agreed with what had been said, and was delighted with the simplicity, economy, and efficiency of the invention, as the inauguration of a new and better system.

Mr. Exall, of the firm of Barrett, Exall & Andrews, engineers, &c., of Reading, said that he was happy to affirm that the importance and advantages of the invention had not been overstated or exaggerated; nothing more important had been invented since the days of Cort, to whom, neglected in his lifetime, the present day, stimulated by these new views, would do justice. He also would rejoice in the prospect of the trade being freed from the thraldom of the puddlers. "All processes which are more economical, and render the manufacturer independent of the caprices of those employed by him, and which at the same time produced a more uniform quality, and greatly increased quantity of so important a staple, must be of world-wide interest; he looked, therefore, with some uneasiness at the possibility of Mr. Bessemer's permitting a monopoly of its use to fall into the hands of one or a few iron-making firms, and begged him carefully to consider whether the interests of the world did not demand his throwing it open to the world at a fair royalty."

In the *London Repertory of Patent Inventions* for October, No. 754, and in *Newton's London Journal of Arts and Sciences* for October, No. XXII., are full specifications of Bessemer's patents for improvements in the manufacture of railway wheels, dated Oct. 17, 1855; for improvements in the manufacture of iron and steel, dated 15th Sept., 1855; for improvements in the manufacture of iron, dated 7th Dec. 1855; for improvements in the manufacture of iron and steel, dated 4th Jan., 1856; and for improvements in the manufacture of malleable or bar iron and steel, dated Feb. 12, 1856; with numerous engravings descriptive of his instruments. In *Newton's L. J.*, p. 210, there is also a specification of Martien's patent for improvements in the manufacture of iron and steel, dated 15th Sept., 1855, without illustrations. Opening this October number, the editor apologizes for the space occupied by these specifications on the score of the all-absorbing interest of the public in the subject, and adds, "that at present we have heard or read of nothing, which in our judgment can be accepted as a proof either of the inefficiency of Mr. Bessemer's process of converting crude iron into malleable cast iron, or of the invalidity of his claims to novelty." When claims "bear date so nearly to the patent they are intended to trip up as Birch's and Martien's do to Bessemer's, the value to be put on their phraseology is much more difficult to ascertain. . . . . It depends in a great measure on himself whether the validity of his patent shall ever be questioned in a court of law. . . . . We should be sorry to see Mr. Bessemer so ill advised as to throw away opportunities for realizing that reward to which his labors so justly entitle him; but if reasonable, and even liberal offers are, as we understand they have been, refused, he will doubtless in the end form one of that numerous and motley class who are entitled to bear the unenviable motto of 'virtue unrewarded.'

"The specification of Mr. John Birch's patent for improvement in the manufacture of iron, dated 30th June, 1855, is also given (p. 209), with plates, showing the sectional elevation of a blast and refinery furnace combined, wherein he shortens both processes, and smelts and refines by one fire, by employing both reducing and oxidizing tuyeres at the same time; thus dispensing with the use of the refining coke. He blows his blast through water-boxes surrounding the refinery fire. He 'claims the peculiar arrangements of furnaces, and the process pursued in their application to the manufacture of iron as described.'"

A writer, on p. 647 of the *London Mining Journal*, reviews the whole subject, and the various patents, in substance thus:—

"Mr. Charles Sanderson's process, described on p. 527, and commented upon on p. 519 of the August 2d number of the Journal, involves the use of chemical agents directly applied to two or three tons of melted iron in the hearth of a reverberatory furnace (whether run in from a blast furnace or remelted) after being skimmed of the cinders—by which, 1, a clean cinder is got, and the loss of iron diminished from 2—4 cwt. to 100—60 pounds per ton;

2, a uniform refined pig iron is got without blast; a tough, strong, clean metal, which, when puddled, produces a superior clean, tough, not at all red-short, long-fibred bloom; 3, the cost is diminished to such a degree by the fact that the refining furnace, without coke, without blast, and with one-fourth of the old waste, will keep pace with the blast furnace, that the iron can be made for six or seven shillings per ton, including the royalty; the cost of producing refined metal by the old process being about twenty shillings. Several hundred tons of this metal have been made and variously tried. What the chemical re-agent is, is not stated, further than that it must be capable of giving out oxygen during its decomposition to seize upon the carbon in the iron, making carbonic oxide, which in turn seizes upon the earthy impurities, and obliges them to drop their iron into the general mass. In fact, the process treats the hearthful of liquid metal as a chemist would treat a spoonful in his crucible. This is therefore a process, not for obtaining malleable fibrous iron, but for obtaining a refined metal in a speedy, cheap, and copious way.

"Mr. Avril's oxygen blast involves certain unexplained expenses connected with the first obtaining of the oxygen, and therefore no estimate can be made of the chances in favor of its use in the manufacture. It is a refinement upon Mr. Sanderson's process, by which the chemical oxygenating agent is dealt with outside instead of inside the furnace: and so far as ideal perfection in chemical manipulation goes, it is certainly in advance of Mr. Sanderson's process.

"Mr. Reuben Plants' invention has no idea of doing away with, but merely assisting the puddling process, shortening it by decarbonizing the iron more rapidly by his air and steam blast. He considers that if he were to blow until all the iron were consumed, he could not change pig iron into any thing else, unless the 'robble' were used, and the iron paste collected while the slag remained still liquid.

"Mr. Gurlt's invention ignores the puddling furnace, and attacks the ore itself with blasts of air and gas from gigantic tuyeres—not in a blast furnace of the ordinary form, but in a sort of *treppenrost*, in a long tube placed slanting, the blasts inserted two-thirds down. The advantages are an indefinite length of tube, and therefore economy of fuel, and the use of a gas for fuel which has no silica, no phosphorous to form a slag to interfere with the work and debase the iron. The expense of this process also is, however, quite unknown; and the product is much more likely to be, not malleable iron, but refined pig.

"Mr. Nasmyth's invention was the acknowleged father of Mr. Bessemer's, and, like it, produced crystalline iron; but the bursting of the great Nasmyth Gun at the first trial may have been due to the burnt condition of the iron, as described in the acount of the fracture of Bessemer's ingots.

"As to Bessemer's iron, its crystalline structure, if pure, need not deter manufacturers; for it only remains to discover some way to press the crystals into an overlapping attitude to one another to make the tough bar. If this cannot be done, if fibre of iron or fibre of slag, be needful for toughness, then Mr. Bessemer has succeeded in obtaining nothing but refined pig metal.

"Mr. Martien's process is substantially the same, but Mr. Martien takes a more practical view of the case, and cannot yet persuade himself that the puddling furnace is unnecessary. He merely purifies his pigs, but does it in the tap gutter by simple machinery, in a simpler and speedier way. His gutter, however, may assume any shape which experience hereafter may prove best adapted for the purpose; and his refined pig metal may flow forward into the puddling furnace. This will be, then, his only difference with Bessemer: Bessemer will refine in a separate receptacle, the lining of which must be kept always in repair, and the gutter too. If Mr. Bessemer calls his yield 'malleable iron' and 'cast steel,' and Mr. Martien calls his yield 'refined pig,' the chemist, the practical iron-master, and the manufacturer, must all three be called in to decide upon the difference; and, for my part," concludes the

writer, "I shall buy 'refined pigs,' as they will evidently be sold at a lower rate than 'cast steel.' Another reason which would induce me to do so is, that it seems bad policy to puddle 'cast steel,' and yet with metal produced by Mr. Bessemer, and called by that name, puddling and the various other usual manipulations appear to me the sole processes which would render it nearly equal to 'cast steel' ordinarily sold as such, whilst, if the metal be burnt as much as some which Mr. Bessemer has produced, I am at a loss to know what could be done with it."

IRON FURNACES.

The Boonton Iron Works.—This is one of the largest establishments in the United States, located at Boonton, Morris County, New Jersy, on the Morris Canal. Its location is excellent, and its general arrangements are well adapted for doing a large business on the most economical principle, and being so advantageously situated, that all their extensive works are driven by water power. It has a waterfall on the Rockaway River of over 150 feet high, where there is generally an abundance of water, and this great height of fall is got in about 1,000 feet in length, so that eight water-wheels can be driven by one continuous stream. Those wheels are of great power, being from 18 to 22 feet in diameter, and from 8 to 18 feet wide in the bucket, and at the same time so located as to render the works compact and convenient. All are overshot; thus giving an enormous amount of power. The Morris Canal passes directly through the works, and enables them thereby to convey every thing to and from those works without incurring the cost and expense of reloading and shipping, which in a great many other such establishments they are compelled to do at a large expense, by reason of their being inconveniently located.

There is every necessary arrangement for manufacturing spikes and nails of the best quality; hoops and chair iron, and also rolled iron of all sizes and descriptions; here, in fact, is also all the necessary machinery and arrangements, not only for converting the ores into pig iron, and thence into nails, &c., but here is also the requisite machinery for converting the trees of the forest into kegs. The works are supplied with iron ore of excellent quality from their own mines, which are also located in Morris County, on or near the line of the Morris Canal, and about nine miles distant from the works. In relation to the extent of those mines and of their productiveness I shall speak hereafter.

Those works and mines are owned and carried on by Messrs. Fuller, Lord & Co., New York. In order to show, to some extent, the capacity of those works, I may here mention a few facts, showing forth the amount of some of the different articles there manufactured and produced, and to some extent the amount of materials consumed in the year 1855. The number of persons employed at the works is about 600 hands. There is in operation one blast furnace, 12 puddling or refining furnaces, 120 nail and spike machines, with all the necessary appliances, from which was produced 6,717 tons of pig iron, 145,000 kegs of nails of the different sizes, 15,000 kegs of railroad spikes, and 7,148 tons of iron rolled; also 180,000 kegs were made by machinery from the logs of wood delivered at the works for the purpose. There was also consumed in the same time 25,000 tons of coal, 14,500 tons of iron ore, and over 6000 cords of wood. I can give you here but a poor idea as to the extent of those works. They are well worth a visit to see; and I know of no place where a lover of progress would enjoy himself more than by a visit to the Boonton Iron Works.

Respectfully yours, &c.,

PRACTICE.

A correspondent in Ohio, who, we trust, will pardon us for taking the liberty to publish some extracts from his letter, writes us as follows:—

There are two new furnaces in Lawrence County, Ohio, this year—vi

Pioneer, stone coal (hot blast, recently gone into blast), 14 feet bosh, 45 feet high, 5 feet blowing cylinders, and 24 inch steam cylinders, in section 15, Washington Township; ore, limestone and coal, contiguous to the furnace. Coal comes from the mine within 50 yards of the tunnel head, and 20 feet above it.

2d. Oak Bridge Furnace, commenced 15th August; machinery now being erected 12 feet; bosh 44 feet high; 4 feet blowing cylinders, and steam cylinder 18 inches, both six feet stroke; 2 boilers over tunnel head, 44 feet long and 42 inches diameter; these, and hot blast heated by the escape heat of the furnace, as is usual with all the furnaces of southern Ohio, except Pioneer, the hot blast of which is heated by a separate fire. We have nine seams of workable ore in all the hills around the furnace, in horizontal strata running through the hills; also 4 workable seams of good coal, the main seam of which, near the level of the tunnel head, is seven to eight feet thick, and opened in numerous places within 100 to 1,200 yards of the furnace, unsurpassed as a good coal for fuel, and we think for iron making, with 5 seams of limestone at different heights in the same hills, where ore and coal were not supposed to exist by the people or by the iron-masters four months ago. We are seven miles from the Ironton Railroad, 15 miles from the Scioto and Hocking Valley Railroad, and 12 miles from the Ohio river (though our lands, 9,500 acres, extend within three miles of the Ohio, and there are numerous good sites for furnaces on our property). The furnace is in section 22, centre of Aid Township, Lawrence County.

I have on my own individual property 10 sites for stone-coal furnaces, as favorably located for cheap production of pig iron as this in Jackson and Lawrence Counties, where the materials for making a ton of pig iron will not cost more than $7 delivered on the stock bank: so you may see from this that I have grounds for saying that pig iron can be made for $11 to $13 per ton. There are numerous localities in these counties as favorable as mine and those of my partners. $18 per ton will pay for the conversion of pig iron into rail bars, when coal is so convenient. It will cost us not more than 62 cents per ton to dig and deliver our coal in the stock yard. This is not intended for publication, but merely to give you an insight into the capacity for the cheap production of pig iron and rail bars. We can compete with the Welsh bars even in New York, even if the duty was removed, and will in future years. We only want capital and enterprise employed. All that we lack is *capital*. The furnaces at Massillon bring their ore 25 miles by canal at a cost of $3 per ton average, and coal seven miles by railroad, at a cost of eight cents per bushel, $2.24 per ton. Most of the anthracite furnaces bring ore from a distance and their coal also, that make the cost of the materials for making iron far more than with us; also provisions and labor are far more expensive

Salt Lick Furnace, Jackson County, using the celebrated Jackson coal raw, as it comes from the mine, has been in blast five months, makes iron that sells for the same price as the best charcoal pig, makes the best quality of bar iron, and works well for horse-shoes and horse-shoe nails; and another stone coal furnace three miles from the Salt Lick furnace, of the largest kind, intends to use the same coal also raw, is called the "Young America," is now building, and will probably go into blast next summer.

CONVERTING IRON INTO STEEL—NEVILLE'S PROCESS.

The following article from the pen of Dr. Tuttle, describes a process which is in operation in this neighborhood:—

Having been invited by Mr. John P. Farrar to visit the Damascus Steel Company's Works, to witness the "Neville process of converting iron into steel"—last Saturday morning,—though it is no joke, if one lives in the

suburbs, to get out of bed early enough to take the Staten Island boat at half-past eight,—we accepted the invitation. Our party was a small one—consisting of our host, two practical iron men (always skeptics of all new processes by instinct,) and two chemists, (always schemers by education), and one more, as a make-weight. The hour or so that it takes of a winter's morning to get from Whitehall to Port Richmond, where these Damascus people are located, was spent in talking over the possibilities of Mr. Farrar's claim. He said we should see old iron, of our own selection, converted in the course of a few hours into excellent steel, and take home if we chose tools made of it under our eyes. But we remembered that steel was no such Minerva-born product; that the English, who furnish the best in the market, select their iron with great care from the Swedish or Russian mines, then pack the pigs in charcoal, and having sealed all tight with clay, keep them in the cementing furnace for at least eight days, at a glowing heat, and allow as many more for the cooling process, before the "blistered steel" is produced; that after this is melted and run into ingots, they let it lie acclimating as it were to its new condition, before forging, or rolling or casting it for any delicate purposes. That a Yankee should take old iron, and turn it into steel tools between breakfast and dinner, was not quite credible.

Moreover, thousands of experiments had been tried, and many have lately professed to work this important conversion, and yet iron men tell us that steel is as high as ever, and the old orthodox process the only practicable one. We have hardly got over our disappointment on hearing that Bessemer's patent, whose beautiful theory bewitches the chemists, cannot work uniformly enough on a large scale to render the quality of the steel at all certain, the process not being sufficiently under the control of the metallurgist for him to predict just when the stream of oxygen should be cut off. Uchatius's method is the last one talked about. It very ingeniously fuses the granulated cast-iron with iron ore, reduced to powder, and the peroxide of manganese Trials of this process have been made in Paris and in London, but on this side of the water we have only heard of it.

Holding up at Port Richmond, we took a brisk walk of three-fourths of a mile along the shore, and reached the works of the Damascus Company. Mr. Farrar rolled up his sleeves at once and went to the day's work. There were lots of old iron lying about—some specimens so rotten they could not be rolled or hammered, others, consisting principally of punchings, and others of bits of old gas pipes. The operator expressed his willingness to use either of these, holding that at base all irons are the same as all golds are, all silvers, all coppers—if only the impurities are expelled, and to do that there is no difficulty, if he but knows the iron.

Four black-lead crucibles were taken, and into each 40 pounds of a mixture of the punchings and gas-pipe ends were placed. Into each of two of these the following were added:

Half an ounce of the yellow prussiate of potash.
One ounce of sal-ammoniac.
Forty pounds of iron.
Eight ounces of charcoal.
One gill of salt.
Three and a half ounces of manganese, or brick dust,

and it was predicted that these two crucibles would, ounce for ounce, with the iron, give steel of the first quality.

To the other two precisely the same materials were added, with the exception of the yellow prussiate, but in different proportions, as follows:

Four ounces of sal-ammoniac,
Three and a half ounces manganese,
One ounce charcoal,
One gill of salt.

The contents of these crucibles, it was predicted, would turn out a pure, and exceedingly tough iron. The crucibles were covered with lids of clay,

and deposited at 20 minutes after 10 o'clock—the two pots for iron together in one furnace, and the two for steel together in another. The furnaces had never before smelt the fire, the mortar was still green, and we were warned, in view of the newness of every thing about the premises, that some delays might occur; but in a few minutes the blast was in operation, and out of every furnace mouth, (for beside those which our experiment engaged, a dozen others had been filled by the workmen in the natural course of their day's work,) around the slabs of clay that lightly covered them, the delicate blue and white flames were streaming. During the three hours that the furnaces were to be closed, we talked over the theory of the thing.

All iron in common use is presumed to have some impurities about it, especially of sulphur and phosphorus. To conquer that the sal-ammoniac and the salt were put in—for the hydrogen of the sal-ammoniac, at a certain heat, unites with the sulphur, and they pass off together. It is the presumed amount of sulphur in the specimen that determines the quantity of the ammoniac and salt—if the rotten bloom had been selected, a larger proportion would have been added. The yellow prussiate and the charcoal furnish the carbon. Now steel is nothing but pure iron, with a small proportion of carbon in perfect combination with it. Any thing that will furnish the iron with that carbon will make steel of it. But carbon, when it is just born out of one state into another, very readily unites with any thing capable of absorbing it—and so probably the purified boiling iron in the crucible gets its carbon, not so much from the powdered charcoal as from the cyanogen of the prussiate, one of whose two parts of carbon uniting with the phosphorus present burns into flame, while the other part freed from all engagements hastens to the embrace of the iron. Prussian blue or the red prussiate would yield just as much nascent carbon, and so make just as good steel, but the hunt is for cheap materials, and the yellow prussiate, which is dirt cheap, answers well enough. The manganese serves simply to form the scoriæ—the air-tight cover to the melted mass in the crucible—and brick-dust would answer just as well, or any thing else that would as surely seal up this chemical marriage from prying eyesight not only, but even from the curious air.

The three hours were up at 1.20 o'clock P. M. At that minute precisely two brawny "pourers," with their boots and legs enveloped in many thicknesses of woollen rags still dripping with cold water, pushed aside the furnace tops, lifted out the crucibles, and skimmed off the scoriæ, and slowly with an even stream poured their contents into iron moulds. Aside from the beauty of the white hot metal, the coolness of the sweating pourers, and the brilliant light that invested the dusky objects about, there was great interest attaching to this operation from the fact that we had always been taught that wrought iron cannot be melted. You can make a doughy mass of it, said our old master—a kneadable paste—but you cannot pour it. Here, however, we saw the thing done. The scraps of old gas pipe and punchings were certainly wrought iron, and here they certainly were running over the lip of the crucible as freely as cream or West India molasses in summer.

In a few minutes the moulds were knocked apart, and the ingots were left to cool upon the sand; now it required some three hours for such a mass to cool as thoroughly as it ought to—for the atoms to granulate—to become used to their new condition, and to assume all their characteristics.

The English manufacturers let theirs lie for 6 months before they will consent to work them up. When one hour had elapsed, however, our ingots were taken in hand again, thrust into the heating furnace, and brought to a red heat. Then they were put between immense rollers, rolled into bars and sheets—which last are, by this time, we presume, packed off to Ames's to be made into shovels and spades. The trip-hammer of the establishment was not geared; so, after the rollers had brought one of the bars to a workable thickness, the bar was forged by hand. A thin piece of it was shaped into a cold chisel, which, when tempered and ground, stood well the severest tests.

It cut into the iron of the trip-hammer very much as if that had been so much lead. Other pieces were broken. These showed a beautiful fracture, whose fine grain no microscope present could reveal a crystal in. The crucibles containing the iron were meanwhile turned out, and after cooling an hour, their contents thrust into the heating ovens and then subjected to the rollers. Pieces that were rolled as thin as stovepipe seemed for toughness and for beauty scarcely inferior to the best Russia iron. Other pieces were rolled into bars, and forged by hand—thus showing us another marvel, to wit—that iron, which we had seen cast, could be rolled and forged, all which the old workers in iron are in the habit of telling us is quite impossible. So far as we could judge, the experiment had been entirely successful, and the steel seemed to be of the finest quality. We understand that this Company has already turned out some hundred tons of it, which is being worked up into tools at several places—at the West Point foundry—at SCHENCK'S, in Howard Street, and at JOHN JOHNSON'S gas-fitting establishment, where it is pronounced as good as any in use.

The advantages of this process, if on the large scale it works as well as it does on a small one, are several.

First—Any iron will answer for the purpose. Under the common process a specific iron must be chosen with great care.

Second—It is a great saving of labor and of time. This process can be begun and completed on the same day, though, perhaps, it would be better not to heat the ingots until they have lain a night. The common process requires from 16 to 40 days to bring the iron into the condition of *blistered* steel.

Third—Experience shows that it is very difficult, in the common process, to make the bars of iron absorb the carbon in equal portions at the centre and at the surface; consequently specimens of the same fineness must be selected with the greatest care out of many different bars. In the new process, the chemical which gives the carbon is melted in the same pot with the iron, and there can be no possibility of an unequal distribution of the carbon through the metal. For these reasons, if there is no hitch that we have not dreamed of, this process will furnish steel at very little more than the cost of bar iron, which must be a reduction of some 66 per cent. in the price of this most important article. Old iron can be had at from $30 to $40 per ton; prussiate of potash sells at 32 cents per pound; sal-ammoniac at 10½ cents. The other materials—salt, manganese, charcoal, you buy by the sack or load, and scarcely need to be reckoned. The whole of the chemicals for a ton of steel scarcely cost over 60 cents, and the difference between the iron and steel made on these premises is not over 50 cents per ton.

The inventor of the process is JOHN NEVILLE, a burly, rough-looking Englishman, who would have been a Yankee if he had been born two years later. It was a study to see the tough old Vulcan as he stood warming his toes at the mouth of the furnace—the joy of his heart not quite concealed by the grime on his face and his slouched hat-brim—as a red-hot slab of steel was emptied from the mould. "Isn't it beautiful?" said he. We asked if he had never seen it in his dreams before. "Yes," said he, "and it has given me an empty belly many a day." He had arrived at the conclusion that the yellow prussiate was the thing which was needed to carbonize the iron, from witnessing the common process of case-hardening, in which the bar of iron that has received its final shape is coated with the prussiate, and then subjected to high heat. The iron, for a short distance from its surface, absorbs the carbon from the decomposition of the acid of the salt, and is, to all intents and purposes, steel; while the interior of the bar remains, as it was cast, of malleable iron. Now, reasoned Mr. NEVILLE, if, by this process, the surface of the iron can be made steel, why cannot the whole mass be converted into steel, if the salt and all the parts of the iron can be brought into contact, and they certainly can be by melting them together. Possessed of this idea,

he has never ceased from torturing the two materials together when he could raise the funds to experiment with. He succeeded, some year or two since, in arresting the attention of Mr. FARRAR and Mr. ELISHA W. ANDREWS, with whose assistance, the first at the chemical, and the last at the mechanical department, experiments on a large scale have been conducted at Croton, and are now opening at the Staten Island works. It seems as if enough might soon be done to satisfy iron dealers that we are paying three times as much for steel as is necessary, and enough has been done already to excite the most lively interest on the part of all those who have steel to buy, or those who in their daily manipulations have steel to use; and who, in this age, that eats a meal or whittles, is out of one or the other of these classes?

JOURNAL OF GOLD MINING OPERATIONS.

THE TASMANIAN GOLD FIELDS.

Some very interesting facts relative to the recent discoveries in the Fingal Gold Fields are brought to us by the Hobart Town Advertiser, of a late date. We have concluded to present some portions which may be sufficient to afford a satisfactory representation of those distant gold regions. No other accounts of this region are to be found, to our knowledge, in this part of the world.

A Mr. Clark, appointed by the Gold Committee at Hobart Town, has made an extensive statement of the results of his examination:—

The topographical and geological features of the district appear to be in strict analogy with those of many gold fields in New South Wales and Victoria.

The impression made by the first examination of these features is favorable to the expectation of gold; and this impression is, no doubt, strengthened in the minds of some by the abundance of quartz veins and quartz detritus which every where abound on the slopes of the slate hills near the South Esk.

The structure of the country may be briefly defined as agreeable with that of some of the auriferous regions north of Bass's Straits. Hills of granite, supporting highly inclined beds of slate, a schist, and arenaceous claystone, which are charged with veins of quartz cutting through the strata, or "interlaminated" with them—the whole underlying a conglomerate of quartz and iron, which is of doubtful age, or surmounted by "mountain limestone," or other members of the carboniferous formation—these capped by an enormous overflow of greenstone and other similar igneous products (which, at points of eruption, have intruded between, and have hardened and silicified the disturbed beds), constitute the mass of the country on the banks of the South Esk and St. Paul's River basins.

The surfaces, are, moreover, strewn in various places with fragments of quartz, ironstone, and other drift, from the granite upwards, accumulations of which may be observed opposite to Mrs. Cox's residence, near Gilligan's, and elsewhere.

The quartz gravel and ironstone I traced so far down the South Esk as the right bank of Stony Creek. I had previously, in my first journey from Launceston, noticed the same gravel and some of the palæozoic rocks of north Cleveland; and the forms of the low hills on each side of the country between that place and Perth, convinced me that the very formations I have since seen

in the neighborhood of Fingal, extend over a considerable tract of country north-east and north-west of Cleveland.

On the South Esk and its tributaries the slates and schists exhibit the same kinds of irregular undulations which I have observed in the strike and dip of similar rocks in some parts of Victoria and New South Wales. The normal strike is meridional, in which case the strata or cleavages are vertical; but a considerable oscillation occasionally takes place in the strike, throwing the dip also on each side out of the true east or west direction, and producing various contortions of the beds. For a long distance on the banks of the South Esk the strike varies between N. 20° W. and N. 35° W.; and I found that the quartz veins which run N. ° W., are auriferous. They appear as if bedded with the slates, and like the latter, are inclined from 70° to 80° to west or east, or are rectangled to the horizon.

Some of these veins would, I conceive, produce gold by amalgamation; whether those which cut the strata are visibly auriferous, or contain gold invisibly diffused, are questions suggestive of further inquiry. I have taken some specimens for experiment.

The silification of the slates in some parts of this field is a remarkable feature. The slopes of the granite, where it is in contact with overlying rocks, are covered by fragments of hardened and silicified and granitized beds, and of quartz veins, which are therefore probably to be referred to the action of the granite. The most minute undulations of the laminæ of the once softer material are stereotyped by the hardening which they have undergone. Here, then, is evidence of the transmuting forces which constitute one source of phenomena in auriferous rocks. The silicification which the beds of limestone in contact with intrusive greenstone have undergone near the burial ground at Fingal, is in exact accordance with what has taken place in limestone of nearly similar age altered by greenstone, in the Peel River Gold Field, New South Wales.

In the gully in which the Fingal gold-workers are now working, the rock is so impregnated by silicious matter as to have become a quartzite, and through this hardened rock quartz veins run in all directions. I was reminded of what I saw in the bed of the Shoalhaven River, near Bungonia, in New South Wales.

The softer slates and schists are more in accordance with some of the rocks in the gold fields of the Bathurst country, and along the Yarra Yarra and Anderson's Creek, in Victoria. With the latter there is so great an analogy, in many respects, that I am inclined to believe that the Fingal ranges may be found of somewhat similar productive power. Should such be the case, you may then reckon on a gold field which will support for a time a limited population.

My opinion is, that the gold-washers will find considerable difficulty in realising the gold from such detritus as they are now occupied in cradling, in consequence of the want of tenacious deposits to secure it—the abundance of water—and the fact that they are employed where there are no "bars" across the gully, in consequence of its direction being nearly coincident with the strike of the hardened strata. Some persons imagine that there are no alluvial deposits in this field. I am inclined to think that, even if true, the conjecture is premature. No one has yet tried the flats or the valley along the foot of the ranges, and, in consequence of the flooded state of the ground, no one can at present try them. Nor as yet have any attempts been made to test the character of the flats *above* the gullies, and the table lands under Ben Lomond and along its upper spurs, though an opinion might be ventured as to the possible value of such tracts as the Black Boy Flats and others of similar kind. The whole valley from the present diggings round to Fingal and Avoca, and the valleys of the Break-o'-Day and St. Paul's River, ought to be carefully prospected.

There are, I doubt not, some spots where gold will be found near those localities where the accumulation of drift gravel is greatest, and it seems to me strange that such indications should have been neglected.

I am led to believe that drift gold may be found from other sources besides the veins of quartz. The greater part of the gold from the latter source is of one character, but I have seen other kinds; and some minute particles I saw washed that must have been drifted along the creek in the gully, and beaten flat in the passage downwards. Moreover, I have seen many fragments of blue slate filled with pyrites, which is a known source of gold, as on the Peel River and Hanging Rock in New South Wales. The abundance of greenstone also leads to a conjecture, that in the upper regions that rock may carry auriferous quartz veins, as on the Peel River. I have seen none that I know to be auriferous; but I have abundant evidence that much silex lines the joints of the greenstone in places; and even in the little patch of greenstone that crosses the road at Green Ponds, there are no less than ten or twelve thin seams of quartz in the space of a few hundred yards. I merely suggest this as a field for inquiry. I have seen similar seams in the greenstone on Spring Hill and at St. Peter's Pass.

The above remarks will apply, *cæteris paribus*, to all the country where the geological structure is like that about Fingal. But I would caution the diggers not to be led into the belief that all quartz veins are likely to be equally productive. They have one guide in the direction pointed out before; and below such veins as those which strike from N. 20° W. to N. 25° W., some gold will be probably procured where there is a capable soil to receive it.

I must add, that the present season and the state of the ground—the higher peaks being under snow, and the valleys under water—are insuperable difficulties in the operations necessary to test the value of the Fingal country. Any labors of the kind must be attended by considerable expense, and will probably realize very slight results. But when spring time returns, a careful and elaborate search of all the localities in which the geological conditions of the country are the same as those described above, should be undertaken by a competent person, accustomed to the work.

In a subsequent report Mr. Clark thus continues:

In my report on the Fingal Gold Field, I directed my attention to the probable value of the quartz veins traversing the schistose rocks on the banks of the South Esk, as well as the possible value of the alluvial deposits; and I stated my belief that of the former, some "would produce gold by amalgamation." I also mentioned that I had taken some "specimens for experiment."

It may be useful and satisfactory to the Committee to know the result of the experiment. I therefore do myself the honor of reporting to you hereon.

Wishing that no advantage one way or the other should be derived from my own prejudice in favor of an opinion already expressed by me, instead of undertaking the experiment in person, I submitted the same to Mr. Charles J. Hodgson—who has on former occasions conducted similar experiments for me—two samples of quartz, requesting him to be very careful in ascertaining the proportions of gold contained in them.

I marked the samples A and B, but did not communicate to Mr. Hodgson the localities, or the colony from which they were taken.

The sample marked B came from the slopes of granite on the left bank of the South Esk, near Avoca. That marked A consisted of two portions of a quartz vein striking N. 20° W. in the spotted yellow slate of Specimen Hill.

B weighed 10 ozs. avoirdupois; had a specific gravity of 2·65, and yielded gold in proportion of 3 ozs. 8 dwts. 14 grains to the ton of quartz.

A weighed 16 ozs.; had a specific gravity of 9·70; and yielded gold in the proportion of 15 ozs. 3 dwts. 19 grains to the ton of quartz.

There is no doubt, therefore, that I did not mistake the probable capabilities of the veins I examined. The samples sent to Mr. Hodgson contained

"no visible gold whatever;" and he assures me that he could not detect with a lens the slightest appearance of the metal in the powder of the crushed quartz. Moreover, he informs me that the quicksilver used by him in the experiment was distilled beforehand, in order to prevent the possibility of any accidental mixture of extraneous amalgam. So far, then, as these samples are concerned, the trial has been successful. But it may be as Mr. H. suggests, and as I am inclined to believe, that the gold is not equably distributed in the quartz; and therefore it may be more satisfactory to have larger samples subjected to amalgamation. If you will, then, supply me with samples from localities which I will indicate to you in a private communication, I will endeavor to have my opinion more fully tested.

The subject of quartz-crushing has always been a favorite with me. I believe my letter 8th of July, 1851, addressed to the Editor of the Sydney Morning Herald, and afterwards referred to by R. C. Gunn, Esq., at the meeting of the Royal Society of Van Diemen's Land, held on 13th August in that year (Proceedings, vol. ii. p. 167), was the very first statement bearing on that subject ever published in any of these colonies; and I think I may conclude that my experiments were the first that were undertaken. Since then experience has led me to believe that a vast amount of gold has been neglected in consequence of the natural preference of gold seekers for surface or deep alluvial deposits; for many veins (or "reefs," as some call them) of quartz which are not visibly auriferous have been treated with contempt, because no great amount of alluvial gold has been found in their vicinity,—the popular mind not realizing the possibility of a hard crystalline rock being saturated, as it were, with gold, without any appearance of it in a tangible form. Doubts, even, were expressed by an eminent geologist at the time as to that possibility. "I must confess, notwithstanding I may be accused of great ignorance, that I do not understand how gold can be contained in quartz so minute as not to be discovered microscopically." (Report of S. Stutchbury, Esq., Geological Surveyor, dated Burrondong, October 18, 1851.)

The common notion is, that gold has been, by the immediate action of dry heat, melted into the rocks that hold it. This view I endeavored to controvert in my reports to the Government, dated Peel River, Nov. 15, 1852, and Walcha, 28th December, 1852. I have suggested therein that heat, acting on liquids holding silica and gold in solution may have produced, through the process of condensed steam, auriferous quartz veins. Such being the case, I conceive that gold may saturate certain rocks, or may combine with them in any possible proportion; that thus, there may be quartz or other rocks with or without gold; that gold may be invisibly diffused, or may be partly invisible, and partly visible, in particles, threads, crystals or lumps,—the visible portions, whether large or small, being the excess of gold or the whole amount in any given mass, which has been seized on by galvanic or other physical forces, and collected or deposited in certain spots in the rock. Such, I conceive, to be the case with some of the auriferous veins on the Peel River, and in one which I saw in the neighborhood of the South Esk.

As in many cases the quartz is intersected by innumerable very minute joints and cracks capable of being acted upon by the elements, moisture, heat, and cold may have assisted in breaking up the surfaces of the veins, and thus have produced the original fragments which, under the influence of subsequent agencies, have resulted in boulders of quartz, nuggets of gold, and the pebbles, dust, and particles found in the drift of alluvial deposits.

And if, as has been conjectured by other geologists as well as by myself, the action of floating glaciers or icebergs during the gold alluvial era may have produced in some localities (as in Victoria) those extraordinary accumulations, or moraines, of decomposed white slate (such as the state of Specimen Hill, locally called pipe clay at Bendigo, and boulders of abraded quartz, the whole, after the process of denudation, may present insulated white hills, such as those which have attracted notice, and puzzled observers in the goldfields of Ballarat or Bendigo.

Considering these views, you will be led to perceive how small veins of quartz, such as those on the South Esk, though prolific to a certain degree, not being of the same calibre as those of Forest Creek, for instance, cannot be expected to produce equal amounts of gold. And further, that, although, as I have ascertained by direct comparison since my return from Tasmania, the softer slates of the Fingal gold-field are identical with some on the Turon in New South Wales, and around Mount Alexander in Victoria; yet, unless the forces that have been employed in the formation of alluvial or drift accumulations were as great in Tasmania as in the colonies to the north of it, we can have no ground for concluding that equal results are to be obtained from gold-digging.

The enormous proportionate space occupied by greenstone and underlying carboniferous deposits in Tasmania, must prevent the assumption of there being in that colony an equal exposed surface of auriferous rocks in any given equivalent area; and this again diminishes the supposed prospective value of the eastern section of Tasmania as an alluvial gold country.

It has been conjectured by a scientific friend of mine in Tasmania, that it is possible there may be a gold drift in the centre trough between the Eastern and Western Tiers. I would merely observe that, having run a barometrical section between the tidal waters of the Tamar and the Derwent, I have undoubtedly found a geological dip of the strata through the country along the major axis of the trough towards the south; but this appears to me to complicate the question, for this trough is occupied by the members of the carboniferous formation, broken up by intrusive forces, with scarcely here and there an outcrop of any thing older, and that formation so broken up is overridden by massive greenstone, with only local drifts. It is contrary to all my experience that gold rocks, which must be deeper and deeper in that trough as we travel southwards from the South Esk, would produce surface drift over the carboniferous beds; and, so far as I have seen, the present surface drainage of the gold-fields of New South Wales, of which Tasmania is evidently a geological outlier, is in nine cases out of ten to the northward, or northward and westward.

If, then, the greenstone does not contain auriferous veins, I see no probable ground for my friend's conjecture. The exposed auriferous rocks appear to be limited to the basin of the South Esk; but it is possible their southern boundary may be obscured between Cleveland and Campbell Town by the overflow there from crateriform openings, of basaltic lava, which seems to be the equivalent of the similar lava currents in Victoria and New South Wales, through which the diggers have pierced, and below which they have come upon auriferous drift. In the present condition of gold-finding in the exposed auriferous formations of Tasmania, conjectures as to what may be under the basalt or greenstone are wide of the mark. The area, too, of the obscured auriferous formations cannot be very great, since between Campbell Town and Ross the carboniferous beds crop out from below the lava beds.

JOURNAL OF COPPER MINING OPERATIONS.

LAKE SUPERIOR REGION.

At this season of the year, we have very few accounts from the Lake Superior Region. We add a few items relative to the close of the season.

CLARK MINE.—The last annual report of the Directors was presented to the Stockholders on the 16th of July, 1855, at which time but little work had been done at the mine. Since then shaft No. 1 has been sunk to a depth of one hundred and fifty-six feet from the surface. The ten fathoms gallery has been opened five hundred and twenty-five feet in length. Shaft No. 2 has been sunk one hundred and five feet from the surface, and the twenty fathoms gallery opened from the bottom of shaft No. 1, sixty-three feet in length. A winze has been sunk thirty-three feet, and a shallow adit gallery opened one hundred and fifty feet, through the earth, to shaft No. 2, for the purpose of draining surface water from that part of the mine. An adit, one hundred and fifty feet in length, through earth and rock, has been opened to shaft No. 1, which drains the surface water from that shaft. Sixty-one and a half fathoms of vein have been stoped. This comprises the amount of mine openings made to the first of this month.

The quantity of vein ground which has been *stoped*, thus far, is small, when compared with that now in readiness for stoping. The Directors have thought it more advantageous to the Company to employ the mine force, during the past winter, at extending the shafts and galleries, preparatory to the employment of a greater producing or stoping force, during this season.

The product of the mine, since the 16th of July last, is eighty-four and a half tons of copper; of this amount, 53 343-2000 tons have been smelted and sold. This has been found to produce nearly *eighty per cent.* of fine or ingot copper. There are over twenty-two tons now at Eagle Harbor, in readiness to go forward to the smelting house. This is estimated to produce seventy per cent.

The Directors are of opinion that the mine will produce as much copper this year as it produced last year, in which case, there will not be required of the stockholders an instalment this year. There has been assessed on the stock, $17,000. The Directors would state, that as the opening of the mine has progressed, their confidence has increased in its eventually becoming dividend paying. The surface improvements are light. Three houses; two horse whims, for hauling from the mine; and shaft-houses, are all the building improvements which have been made. Several acres of land have been cleared and planted this season.

The Company now have employed twenty-six miners, and twenty surface men. Two parties of miners are extending the twenty fathoms gallery each way, from the bottom of shaft No. 1. One party is extending the ten fathoms gallery toward the crystalline trap, from shaft No. 2. This gallery, it is thought, will be opened to the crystalline rock, a distance from its present end of four hundred feet or more. One party is extending the ten fathoms gallery south from shaft No. 1. One party, of four miners, is sinking a winze; ten miners are stoping, in two parties, one in the back of the ten fathoms gallery, between the shafts; the other, in the back of the same gallery, south of shaft No. 1. In all parts of the mine working, the vein contains mass, barrel, and stamps copper. Its average width is about twenty inches. The surface force is employed in the removal of the broken rock from the mine.

COPPER HARBOR.

The mines now in operation in the vicinity of Copper Harbor are assuming quite an important position among our mining interests. The introduction

of foreign capital to work the mines there, is an event most favorable to the development of the country. We may hereafter allude to the manner in which this was accomplished, by the persevering industry of parties interested in mining property there.

The company owning the Clark Mine, in connection with the proprietors of town property at Copper Harbor, are now constructing a road to the mine which is to be graduated to the requirements of a rail road track, with the intention of putting iron upon it shortly. It is found that the summit of the hill can be reached by a feasible grade, without very great expense of excavation, and they have determined to commence at once, at the proper terminus, the construction of the Great Trap Range Railway. Once finished and in operation, for a few miles, its value to the next adjoining locations will be so apparent, that the proper influence of interested parties will be secured to push it westward along the range. In a distance of about ten miles from the Clark location it will strike the great property of the North West Mine, passing in the vicinity of many very valuable mining localities, and assisting essentially in the exploration of them. Beyond this point going westward along the range to Eagle River, it would run in the neighborhood of some fifteen or twenty of the most promising mines on the point. In short, a railway from Copper Harbor to the Cliff and North American mines, would place the entire Keewenaw Point District in direct connection with the finest harbor in the copper district, which is accessible in all weather, and abundantly capacious for any future requirement of our lake marine. This would make the receipt of their supplies a certainty, and their commerce on the lake constant and reliable.

The Clark, Montreal & Bell Mining Co., is the name of a new French Co., with its head office in Paris, France, which has begun operations near Copper Harbor. M. Jules Porie is the Superintendent. They employ about 180 men. They own the valuable water power afforded by the stream which is the outlet of Lake Manganese. This little lake lies some 150 feet above Lake Fanny Hooe, and falls down the side of the bluff in such a manner as to afford a great amount of water power, requiring very little outlay to make it valuable. Upon this stream the company intend to erect the large stamping works and other machinery necessary in mining.

The surveys of the Ontonagon and State Line R. R. have been in progress for six weeks. Several reconnoissances have been made, one of which was on the western side of the river—three gaps in the trap range were examined—and instrumental surveys made on two lines, extending from the Island at the mouth of the river southerly through the trap range. The highest elevation crossed is 590 feet above the level of the Lake, and distant on the line about 12 1-2 miles, making an average grade of about 48 feet to the mile, and a maximum of 70 feet. The part of the line this side of the range is very direct, but considerable curvature is required to get through the range. All rock-cutting is avoided, and the expense of gradation is not great. Descending south from the highest point to the valley of the Ontonagon, the distance is six miles, having a difference of level of about 300 feet—an average grade of 50 feet to the mile, and a maximum of 70 feet.

This, we believe, embraces the most difficult gradients on the entire route to the State line, and they are found to be much less difficult than was anticipated.

It is now satisfactorily determined that the Pewabic Mine will ship a hundred tons of copper, and the Quincy mine 20 tons this season.

MISCELLANIES.

THE SALT SUPPLY OF EUROPE.

Some sensation was produced in the course of the present week, by the recital of the disaster which has overtaken the Cheshire salt mines, by the decrease in the yield of the brine. The principal seat of the calamity is Winsford, where a number of works have been compelled to stop. The salt manufactured in this district, and sent to all parts of the world, is very great. During the last year 130,000 tons of this salt was exported to the United States of America, and in the last ten months the salt sent to the same country increased to 274,000 tons. The quantity shipped in the same time to British North America, Africa, Australia and the East Indies, amounted to 274,268 tons. The export to the Baltic was 34,000 tons; coastwise, 100,000; and for home consumption, 120,000. The total yield for the last ten months has been about 800,000 tons. We are also told that the Anderson and Northwich salt works have decreased 75 per cent. during the last fortnight, and the decrease is said to be still going on, owing, it is believed, to the sinking of the land. Whatever injuriously affects a trade like this, in which a large amount of capital is invested, and on which a population of 30,000 depend for a living, is not merely a calamity in a local sense, but affects more or less the health and comfort of the great human family. The Mersey, which connects this salt trade with Liverpool, is the medium of transmitting the article to the remotest parts of the globe. But the picture has evidently been overdrawn; it is not quite so bad as has been represented, and we derive consolation from the assurance of a practical man, who, commenting on the facts we have stated, adds this pleasant assurance:—

"Since tradition or record of the manufacture existed, there have been temporary diversions of the brine springs from the existing shafts, occasioning the abandonment of these shafs or wells, and the substitution of fresh sunk wells. As the manufacture has extended with gigantic strides of late, so will, of course, these temporary inconveniences occur somewhat more frequently, but nevertheless equally remediable. The best test opinion of those who are most interested is the prices of the article. The quotations remain the same for some weeks—nay, are in fact, rather easier; and it is probably this, as much as the small depreciation in the strength of the brine at Winsford, which causes there, at a few works, the present cessation of manufacture."

The view of the case shows the evil to be merely temporary, involving a serious loss of property to the proprietors, it is true, but not irremediable. The same writer further adds:—

"It is out of the question that the Cheshire salt manufacture can ever fall to the ground, inasmuch as it is the richest salt field in the civilized world; and its situation upon a navigable river in direct communication with the Lancashire coal field, yielding a very cheap supply of fuel for evaporation, as well as its immediate vicinity to Liverpool, permits the production and diffusion (over the whole world) of its produce on such terms as no other salt fields can compete with."

ON SILICA, AND SOME OF ITS APPLICATIONS TO THE ARTS.

"Under all forms silica is capable of combining with bases as an acid. Heat is, however, necessary to effect this combination,—a combination of which all the well-known silicates, whether natural, as felspar, mica, clay, &c., or artificial, as glass, slags, &c., are the results. The common forms of insoluble glass are produced by the union of silica with more than one base. But, when combined with an alkaline base only, silica forms a soluble glass, the degree of solubility of which depends on the proportion which the silicic

acid bears to this alkaline base. This soluble silicated alkali (or water-glass) may be prepared by various processes. Messrs. Ransomes obtain it by dissolving broken flints in a solution of caustic alkali at a temperature of 300° Fah. This water-glass has been applied to several purposes, three of which were noticed:—1. *To protect building-stones from decay.* Stone surfaces, by being exposed to the atmosphere, become liable to disintegration. Moisture is absorbed into their pores. The tendency of their particles to separate, in consequence of expansion and contraction, produced by alternation of temperature, is thus increased. Sulphurous acid is always present in the atmosphere of coal-burning cities, and corrodes the calcareous and magnesian ingredients of oolites and dolomites. As a preventive of destruction, whether arising from physical or chemical causes, it has been proposed to saturate the surfaces with a solution of the water-glass. It is known that the affinity of silica for alkali is so feeble, that it may be separated from this base by the weakest acids. According to the expectation of those who recommend the silication of stone, the carbonic acid of the atmosphere will set the silica free from the water-glass, and the silica, thus separated, will be deposited within the pores and around the particles of the stone. The points of contact of these particles will thus be enlarged, and a sort of glazing, of insoluble silica will be formed, sufficient to protect the stone against moisture, &c. Two portions of Caen stone were exhibited, one of which had been soaked in a solution of water-glass two months before. The surface of the unsilicated specimen was soft, readily abraded when brushed with water, and its calcareous ingredients dissolved in a weak solution of sulphurous acid. The silicated surface resisted the action of water and of dilute acid.—2. Another proposed use of the water-glass is that of *hardening cements, mortars, &c.*, so as to render them impermeable by water. Fourteen years since, Mr. Anthon proposed several applications of the water-glass: amongst others, the rendering mortars water-proof. He also suggested that this substance might be employed as a substitute for size in whitewashing. It was demonstrated by experiments that carbonate of lime, mixed up with a weak solution of water-glass, and applied as a whitewash to surfaces, was not washed off by sponging with water, and that common whitewash, laid on in the usual manner with size, was rendered adhesive when washed over with water-glass.—3. *The Stereochrome of Fuchs.* The formation of an insoluble cement by means of water-glass, whenever the carbonic acid of the atmosphere acts on this substance, or whenever it is brought in contact with a lime-salt, has been applied by Fuchs to the process of *fresco secco*, which thus becomes invested with the capability of receiving and perpetuating works of the hightest artistic character, and which may be executed on a vast scale. The stereochrome has been adopted by Kaulbach in decorating the interior of one of the national edifices at Berlin. These decorations consist of historical pictures, 21 feet in height and 24 3-4 in width, single colossal figures, friezes, arabesques, chiaroscuro, &c. On the effect of the three finished, it has been remarked that they have all the brilliancy and vigor of oil paintings, while there is the absence of that dazzling confusion which new oil paintings are apt to present, unless they are viewed in one direction, which the spectator has to seek for.

SHIPMENT OF QUICKSILVER FROM SAN FRANCISCO.

It appears from a carefully prepared table, contained in the *Shipping List*, that the quantity of quicksilver manifested and shipped from this port during the six months ending June 30th, amounted to 9,047 flasks of one hundred pounds each, equal, at seventy cents per pound, to $633,290. The actual amount shipped, however, probably somewhat exceeds this estimate, as the agents of the New Almaden Mine, (Messrs. Bolton, Barron & Co., of this city,) declined giving the amount shipped by them, and the Custom House books cannot always be implicitly relied upon.

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ART. I. — THE IRON MANUFACTURE OF GREAT BRITAIN — THEORETICALLY AND PRACTICALLY CONSIDERED. BY WM. TRURAN, C. E. No. 13.

(Continued from page 28, vol. VIII.)

SECTION XV.—THE REFINING OF CRUDE IRON.

THE refining process is commonly used in the Welsh iron works, and to a partial extent in the other iron manufacturing districts of this country. In the manufacture of the finest qualities it is universally followed, but with the inferior kinds of bar iron is not so much employed as formerly.

The refining furnace usually consists of a strong cast iron framework surmounted with a short brick chimney. The bottom frame rests on a brick of masonry bedding, above which is laid a floor or hearth of dressed sandstone 10 or 12 inches thick. At each side and at the back, within the vertical frames, cast metal water-blocks are fixed, and a cast iron dam-plate in front, the whole forming a quadrangular space, about 4 feet square inside, by 18 inches deep. On the side blocks, resting on a ledge cast for their reception, and bolted at the ends to the vertical frames, are fixed tuyere plates having openings for the insertion of the water tuyeres. The space over the tuyere plates up to the top frame carrying the chimney, is fitted with stout cast iron plates, bolted at their ends to the vertical frames. In front, resting on the dam-plate, it is usual to have a dust-plate for the convenience of filling and working the fire; at a height of a few inches above this plate in front, and a similar height above the rear water-block, cast iron doors about 3 feet high (through which the working operations are carried on) are hung to each of the side frames.

At a sufficient distance below the inside floor of the refinery, and a few inches in advance of the dam-plate, the casting bed, or pig mould, is constructed. A brick, or, what is preferable, and is now coming into general use, a cast iron cistern about 30 feet long, 4 feet wide, and 2 feet deep, forms the substructure. The casting bed is formed of thick cast iron blocks about 3½ feet long, the same in width, and 6 to 9 inches thick, having side flanches to rest on the edge of the cistern underneath, across which they

are suspended, and sloping flanches on the upper surface to r strain the molten metal within the desired limits. When workin the cistern is filled with water and maintained at the same lev and temperature by a small streamlet; the portion of the mou blocks suspended below the upper edge of the cistern is therefo constantly immersed in the water. The jointing of the blocks each other is done with care, that no metal may penetrate in the cistern below; under ordinary circumstances a thin stratu of fire clay between suffices for this purpose, while the blocks a maintained in close contact by driving stout clamps around co responding snugs cast on the side flanches.

The pig moulds are also made with a flanch running dow the centre, dividing the plate of metal into two widths; and reduce still farther the labor of breakage, they are sometim constructed with longitudinal grooves for receiving the metal- the general dimensions of the grooves being very similar to tho of the mould prepared in the dust bed of the blast furnace for t formation of the original pigs.

The blowing arrangements usually consist of two or thr small nozzle pipes at each side; each pipe is furnished with a su able stop valve for regulating the volume of blast. The conne tion between the metal nozzle pipe and the fixed blast pipe co taining the valves, is generally made by a leather bag fastened the ends around the pipes by screw clamping glands. The leath bags, however, map be dispensed with, and their place suppli by telescopic pipes, having a cup and ball joint as a provision f any variation that may be required in the lateral and vertical rections given to the blast. This mode of connecting has been use at the Dowlais works on 16 refineries about 14 years. first cost is somewhat higher, but in repairs and renewals it h been found much less expensive than the common leather conn tion.

Refineries are also constructed with a single pipe at the bac the frame-work, water blocks, mould, and other portions are th of a lighter description, and the fire altogether is of much smal dimensions. Other refineries are constructed with two, son times three, pipes at the back. They are known as single refi ries, while those having two sets of pipes, one on each side, as the fire described, are known as double refineries. The doul fires are commonly blown with two or three pipes of a side, b 4 pipes may be seen at some works.

Refineries are distinguished as melting-down and running fires. The former melts cold pigs from the blast furnace, old ca ings, and scraps; the latter works on hot fluid iron, run dir from the hearth of the blast furnace.

The melting-down refinery is usually in a building by itse at some distance from the blast furnace; the running-in fire erected immediately contiguous to the furnace, from which t

crude iron on being tapped flows into the hearth of the refinery. This mode of working was first practised at the Dowlais works. It has since been adopted at other works, with a considerable saving of coal, of which we shall have to speak hereafter.

The operation of refining crude iron in the melting-down fire is conducted nearly as follows:—the floor of the hearth is strewn with broken sandstone and a fire lit in the centre; a quantity of coke is placed on this fire and a light blast directed on it to increase the combustion. A charge of pigs, scraps, or broken castings, is next placed on the ignited fuel, a quantity of coke heaped on the iron, and the full power of the blast directed on the mass. The weight of pig, or other crude iron charged, will vary with the size of the fire, but may be taken at 2 tons, and the coke for its fusion at 5 cwts. An intense heat is created, the broken sandstone on the floor melts and glazes the bottom of the fire; after the lapse of 40 or 50 minutes the crude iron begins to melt, dropping through the coke on to the hearth; in about 2 or 2½ hours the entire charge is fused, and lies under the coke. The blast is kept up for a farther period, more cokes are added, the metal heaves and boils with the evolution of gaseous carbon, until the whole is sufficiently decarbonated, when the fluid metal is tapped into the pig mould. To render it more easy of removal and breakage, dams of cinder are placed across the mould at convenient distances, thinning the plate metal at such places sufficient for its easy separation. The iron and cinder escape together from the refinery into the mould, but owing to its inferior specific gravity, the great body of the cinder collects on the surface of the plate. This separation of the refined metal from the cinder by mechanical subsidization, is further heightened by throwing water on the fluid mass immediately that the entire charge has left the refinery. The sudden cooling of the plate renders the metal of a brittle quality, and facilitates its subsequent breakage into smaller pieces to fit it for the puddling furnace.

The time occupied in the operation of refining each fire-full will average about 3 hours. White forge iron is not blown so long as gray pigs; the latter will often require 3½ to 4 hours to be properly refined. In melting castings the operation occupies a still longer period: the large and irregularly shaped pieces operated on require nearly twice the usual quantity of blowing to effect their reduction.

With the running-in refinery the operation is different, inasmuch that the crude iron is charged, or, more correctly speaking, run into the fire in a fluid state; consequently, the time occupied in the melting down fire in bringing it to this condition is saved. These fires, therefore, are able to refine a larger quantity in a given time; and are worked more economically in the consumption of fuel and labor.

The operation is facilitated by throwing in a few pounds of

forge cinder, or the cinder from previous refinings. This cinder does not improve the quality of the resulting plate metal, but it abridges the time and apparently protects the iron, to a certain extent, during the prolonged blowing demanded by certain qualities.

The bottom of the hearth, owing to the intense heat maintained in the process, and the force of the blast being directed on the stones, is burnt down in a short period, and is usually repaired every week. Brick bottoms are employed at some works, and the practice of repairing the hearth by covering it weekly with a course of fire brick is also commonly followed. For durability, however, the sandstone bottom of the millstone grit is superior to all others.

For conveying the blast into the hearth, small wrought iron tuyeres are used, having their lower orifice of 1½ or 1⅝ inches bore, and the larger 3½ or 4 inches. A half-inch pipe is screwed into the upper end as an inlet, and a similar one as an outlet for the water employed to keep them cool. The inlet pipes are connected with a small cistern, placed 3 or 4 feet above the tuyeres; the outlet pipes discharge the water into the side blocks, from one of which it enters the rear block, and finally is conveyed by a small pipe to the cistern under the pig mould.

The nozzles of the blowing pipes in double refineries having 4 or more pipes, are commonly 1⅜ inch diameter; or if of any other section, equal in area to a circular pipe of this dimension. Flattening the point so as to increase the horizontal surface of action, is considered by some refiners as superior to the circular form. The angle which the direction of the issuing blast makes with the bottom, is a matter of some importance to the success of the operation. We have obtained the best results when the line of the blast makes an angle of 38°, and the angle enclosed by the two streams 105°; the meeting place of the streams, if continued, at the upper surface of the hearth.

THEORY OF THE REFINING PROCESS.

The operation of refining is a combination of chemical and mechanical processes, whereby the metallic iron is deprived of a portion of the extraneous matters contracted in the blast furnace. Crude iron contains various substances in alloy; generally the most important consist of carbon, silicum, and aluminum, as will be seen by referring to the analysis in a preceding section; it is the refiner's province to extract the larger portion preparatory to its conversion into malleable iron. For this purpose the crude iron is fused in the refinery fire, along with coke or charcoal fuel, and there kept at a liquid heat for a short period by means of numerous small jets of blast. In the blast furnace the atmospheric air delivered through the blast pipe is required for the maintenance

of combustion; in the refining process the blast answers a double purpose; it creates and maintains an intensely high temperature, fusing the crude iron with great rapidity, and by oxidizing the alloyed matter, expediting the operation. But in the process a considerable quantity of metallic iron also is oxidized, and forms, by combining with a portion of the earthy alloy, the refinery cinder. Hence, of the oxygen of the blast delivered into the refinery, the larger volume unites with the carbon of the fuel during combustion, forming carbonic acid, and ascends into the atmosphere: an inferior volume unites with the carbon vapor evolved from the molten crude iron, forming also carbonic acid and escaping in a similar manner; a minor volume unites with the oxidized metal, forming the protoxide of iron, while the remainder combines with the other alloys forming silica, alumina, and other oxides

The separation of the various alloys is farther facilitated, as in the hearth of the blast furnace, by mechanical subsidization. Specifically lighter than the metal they float on the surface, united in definite proportions with oxide of iron; and to a partial extent protects the lower stratum from farther oxidation during the process.

The decarbonation and consequent refinement of the crude iron may be effected by fusion and oxidation in reverberatory furnaces without the intervention of a blast. When this mode is adopted the refined metal and resulting cinder are directed into separate channels; but since the blast expedites the operation by augmenting the surface of the metal for the action of the oxygen, and results in a superior yield for the same degree of refinement, it is preferable for general purposes.

At the Dowlais works, refining has been conducted with raw coal these several years, but we are unable to discern any real advantage over coke. The substitution was made at a period when the supply of cokes was inadequate to the demand, and in the absence of any great drawback from the change, raw coals were subsequently adopted at other refineries. After an experience of some years, however, we are of opinion that cokes of a good quality are greatly superior to any raw coal for refinery purposes. The heat produced with raw coal is not nearly so intense or concentrated, as the heat produced with a similar quantity of coked coal, and much of the heat developed escapes without yielding any beneficial effect on the operation. The yield of coal is full 1 cwt. higher than was required with the coked coal. With the known greater calorific power of raw coal over that of the cokes produced from it, this increased consumption on the substitution of raw coal requires some explanation. In the blast furnace wherever raw coal has been substituted for coke the consumption of coal has been reduced, but this has not occurred at the refinery; and we must look to the more rapid and superficial character of this process for the solution of the apparent anomaly.

Raw coal when charged into the blast furnace undergoes a distillation in the upper parts of the furnace, and is thus converted into a coke more or less dense, according to its original constituents, and the weight of the superincumbent materials. The temperature of the throat, through which it enters the furnace, is low compared with the temperature in the zone of fusion; and the transition from the lesser to the higher temperature occupies from 30 to 40 hours, during rather more than the one-half of which the distillatory process is in slow operation. The coke on its arrival in the zone of fusion is composed of nearly pure carbon; by the evolution of its gaseous constituents, the dense, solid coal is converted into a cellular mass; the surface area of the carbon presented to the oxygen of the air for combustion is immensely increased, and the requisite volume of atmospheric air being brought in contact with it, a maximum temperature is attained. But in the refining furnace the case is very different. The coal is precipitated into a violent heat without previous preparation, which results in a rapid distillation of its volatile constituents, causing a partial disintegration, and the coking is incomplete when the coal arrives at the intense heat generated by the blast. In the blast furnace the time allowed for the transformation into coke averages 20 hours; in the refinery, from the time of its immersion to its combustion it is barely the same number of minutes. As a consequence of this rapidity of action the coal is only superficially charred, and the surface of carbon exposed to the action of the oxygen of the blast is limited. The conditions necessary to a rapid combustion of the fuel and the maintenance of an intensely high temperature are absent, and account for the inferior reducing power of the raw coal in the refining process.

In practice, the finer complains of a difficulty in getting a good heat on the iron, and when fused this difficulty continuing obliges him to blow longer than with coke. The inferior temperature is caused by the large volume of gases liberated by the coal rendering latent a portion of the caloric produced by the combustion of the carbon. The make of a refinery is consequently reduced while the labor is augmented. As some compensation for this reduction of make, which, measured by the time the refinery is under blast may be taken at 10 tons per week, and for the additional labor with coal, the rates paid the workmen are considerably higher than for coke.

Anthracite coal has been used in refining crude iron, but its proper management in this process is not generally well understood. This coal, owing to the small percentage of bituminous matter entering into its composition, is very liable to splinter and disintegrate when suddenly exposed to a high temperature; attention, therefore, should be directed to remedy this characteristic. At the Ystalyfera works anthracite has been partially charred in ovens, and conveyed to the refinery in a heated state. This pre-

liminary preparation has enabled the refining with anthracite to be conducted with considerable success. An arrangement, however, superior to this might be adopted;-in a suitable chamber, contiguous to, but constructed at a level 3 or 4 feet higher than the refinery hearth, furnished with a small blast pipe, the coal might have its temperature gradually elevated to prepare it for the intense heat of the refinery, into which it could be drawn as required; by regulating the volume of blast admitted, the distillation in the supplementary chamber may be conducted at the rate most advantageous to the structure of the coal and the object in view.

A heated blast has been tried at the refinery, but without any appreciable advantage over the cold. The hot blast, as we have already shown, posseses inferior penetrating power, and to this extent is inferior to the cold. In the refining process a blast of given density is absolutely necessary, if the decarbonation is to be effected with a minimum consumption of metal and fuel. The pressure of the hot blast being equal to that of the cold, its intensity at a given distance from the blast pipe is diminished in an inverse ratio to the augmentation of volume by heat. Hence, to produce equal effect, the nozzle requires to be brought so much nearer the surface of the iron, thereby contracting the working surface of the blast, and increasing the burning and wear of the blocks and tuyeres.

But the effects of a heated blast in reducing the consumption of coal in the blast furnace, are generally cited as a reason for its adoption in the refining process. We have elsewhere shown that the effects produced by the new system have been greatly exaggerated by all writers on ironmaking, and may now state that it effected no saving of fuel in the refining,—the consumption with a heated blast was higher than with a cold. The diminished power of the blast to decarbonate, apparently more than compensated for the lesser absorption of caloric by the blast in its subsequent elevation to the melting temperature.

A difficulty is experienced in refining crude irons smelted from ores of the carbonaceous class, more especially with those produced in Scotland, though the irons produced in Wales and other districts from ores of this class are refined with nearly equal difficulty. The cause of the uniform inferiority of these irons in the refinery is a matter on which a diversity of opinion exists amongst ironmasters. To form a correct opinion of its origin, it is necessary to consider the characteristics of irons from carbonaceous ores: these are, fluidity at a low temperature, caused by an excessive percentage of carbon in combination, and as a necessary consequence of the richness of the ore in metallic iron, an inferior percentage of other alloys. Either of these characteristics in other irons causes the blowing to be of longer duration, and results in an increased consumption of fuel, blast, and labor, and

a greater waste of the crude iron; consequently, we may conclude that an iron containing all three will be refined with proportionately greater difficulty.

From the low melting temperature of this iron, the ordinary temperature of the refinery would result in a large oxidizement of the metal, which is avoided as much as practicable by keeping a lower heat; but with the inferior heat the operation is prolonged, and is attended with a considerable though smaller waste of metal. The excess of carbon in combination with the metal is removed only by bringing in contact with it a proportionately larger volume of the oxygen of the blast—an operation involving at the low working heat a prolongation of the blowing. The small percentage of silicum and aluminum causes the iron to work drier during the process; to correct this defect a quantity of cinders are added, to protect it from oxidizement and otherwise improve the quality for the forge.

Yet, after carefully made arrangements, and the employment of the best workmen, the refining of these irons is attended with great loss of metal. The general consumption of crude iron to a ton of refined plate metal is 24 cwts., or an excess of nearly twice that with gray iron from argillaceous ores. This, added to the large consumption of coal and the reduced make, has operated greatly against their use in the manufacture of malleable iron bars. In the Welsh works so great is the waste in the refining process—partly caused, however, by the workmen being accustomed to iron melting at a high temperature—that the Scotch pigs are not unfrequently charged into the blast furnace, and there reduced along with the local ores, in preference to working them through the refinery at first. By this mode of working the decarbonation is effected in the blast furnace as well as in the refinery, though it afterwards passes in mixture with that smelted from the argillaceous ores. The loss by this double refining, as it were, cannot be accurately ascertained, but from calculation we find the yield to be nearly 25 cwts., to the ton.

On other occasions these irons are refined in conjunction with the pigs smelted from the local ores in the proportion of one-fourth or one-fifth of the fire-full. By admixture in this way the yield is improved, but the decarbonation of the mass is not so complete, and the average quality of the plate metal produced is more inferior.

Iron smelted with caustic lime as flux, is refined with greater difficulty than such as is smelted with raw limestone. The presence of the carbonic acid of the limestone appears to have considerable influence on the fluidity of the iron, both in the blast furnace and refinery. In its absence the crude iron is thick, runs in a sluggish stream, and in the refinery fire requires a longer blowing to raise the cinders and bring out the cellular structure. The cinders are thick and whiter than usual. But the metal from

caustic lime flux is superior to the other for the rolling mill, and the ultimate quality is considerably improved.

The addition of limestone during the refining is attended with beneficial results to the quality of the metal, when the crude iron has been smelted from lean carbonates of the coal formations. The quantity that may be advantageously used is between 20 and 30 lbs. per ton, previously broken small; or the lime may be added by impregnating the cokes with caustic lime, to the amount of 12 to 18 lbs. per ton of iron. When this quantity has been exceeded the manufactured iron has had a red-short tendency. Whether it be added in the shape of limestone or caustic lime, the improvement in quality is very marked, and is probably due to the union of a portion of the sulphur in the iron with the lime. It is generally known that the lean carbonates abounding largely in silica produce finished iron of a cold-short character. The addition of lime in moderate quantities appears to neutralize this tendency, and the resulting iron is comparatively free from the opposite extreme—red-short.

The addition of potash to the iron in the refinery appears to deteriorate the general quality. In experiments where 6 lbs. per ton was charged, the tendency of the metal, whether to hot or cold-short, was heightened by the use of this substance.

The refining of the crude iron results in the deprivation of a portion of its carbon, silicum, and aluminum, and other substances in alloy. The proportion which the quantity removed bears to the whole is difficult of determination. By analysis we find that the composition of a crude iron, and the composition of the refined metal produced from it after 1¾ hour's blowing in a running-in fire, was as follows:

	CRUDE IRON.	REFINED PLATE METAL.
Iron	95.26	98.33
Carbon	2.63	.87
Silicum	1.38	.53
Aluminum	.73	.26
Phosphorus	trace	trace
Sulphur	trace	trace

By analysis also we ascertained the composition of the cinder produced during the refining of this iron to be as follows:

Protoxide of Iron	70.3
Silica	21.5
Alumina	7.8

As a general rule, however, the longer the blowing, and consequent exposure to the oxygen of the blast, the greater the deprivation of alloys and improvement in quality; but the process may be unnecessarily prolonged. By limiting the blowing, metal may be obtained with nearly the original proportion of earthy alloys. For certain forge purposes such iron is preferred to varie-

ties containing less cinder. The quality of the original crude iron, also, may be such that the resulting refined metal will contain a considerable percentage of cinder; for although the presence of cinder in quantity is usually considered as evidence of inferiority, it is well known, that, in the manufacture of malleable iron bars, the most successful results are obtained, when the metal, by freely yielding a fluid cinder, is protected from oxidation. Hence, in refining, the object in view is not so much to deprive the iron of the cinder alloy, except in cases where this is of a prejudicial quality, as to decarbonate the iron. If depriving it of the alloy was the object in refining, as is generally supposed, the gray varieties having the least amount would be refined with facility instead of difficulty. The percentage of carbon principally determines the degree of facility with which the operation may be conducted. If the quantity combined is small, the process will be accomplished with a minimum consumption of crude iron, fuel, and time; if large, the operation is attended with a maximum consumption of materials and time.

The average quantity of carbon in crude iron is supposed to be near 4 per cent. In the refining process this is commonly reduced about one-half, the remainder having combined with the oxygen of the air and escaped as carbonic acid gas. With analytical chemists a diversity of opinion exists as to the relative proportions of carbon in the white and gray varieties of crude iron. By some it is maintained, that the white contains the largest quantity, while others contend, that the gray is richest in carbon. Without going into an explanation of the many conflicting statements which have been published on the subject, we may state, that the consumption of carbon in the blast furnace in proportion to the volume of blast employed, and the weight of the liquid products obtained, directly influences the time required for the subsequent process of refining. If it is large, we find that the iron is refined with difficulty, while that smelted with a minimum proportion of carbon is refined with comparative facility. An addition to the usual burden of coal on the blast furnace is immediately made known to the finer by the longer time occupied in the decarbonation. With this evidence we are of opinion that the white contains the least carbon. But an exception must be made in the case of white iron from a furnace consuming a maximum proportion of carbon. This variety of white iron we consider as being richer in carbon than the gray; for with similar ores the volume of carbon combining, varies with the consumption in the furnace, and is not measurable by the depth of color presented by the iron on the fracture.

The fracture of the refined plate metal when cold is white and dense at the bottom, but exhibits a honeycomb, or cellular structure at top. The depth of the honeycomb is affected by the quality of the iron and length of blowing,—if the metal is from ordi-

nary forge pigs, and the operation has been conducted an average period, it will be from 1 to 1½ inches; but if the plate is from good gray pig it will probably not exceed ½ an inch. By the reduced depth of the honeycomb, and the bright silvery lustre presented by the metal, the general quality of the crude iron used in its manufacture may be accurately determined.

YIELD OF CRUDE IRON AND FUEL.

The consumption of crude iron for each ton of refined plate metal produced from the running-in fire averages 22.3 cwts. when refining common forge iron, and 22.1 cwts. when working gray iron of superior quality. In the melting down refinery the yield on each variety is about 18 lbs. per ton higher.

All the varieties of crude iron smelted with a heated blast, are refined with a greater waste than those smelted with a cold blast. The cause of this inferiority in this process is probably owing to their holding in solution a larger quantity of earthy matter, and melting at a lower temperature than cold blast irons. The consumption of crude iron per ton of refined metal average 36 lbs. per ton in excess of others smelted with a cold blast.

Crude iron smelted from a burden abounding largely in cinder is refined with a greater waste; for though cinder is beneficial when present in moderate quantities, by the protection which it affords the iron, it proves injurious to the yield and quality if in excess. Hence, a large addition of cinder in the blast furnace is generally followed by bad refinery yields.

The products obtained from the refinery exceed in weight that of the crude iron charged; 2498 lbs. of pigs ordinarily produce 2240 lbs. of refined metal and 325 lbs. of refinery cinder, total 2565 lbs.,—excess 67 lbs. The principal portion of the excess of products is due to the fixation of oxygen, forming the protoxide of iron of the cinder, silica, and alumina; the remaining portion is composed of the silicious earths of the coke, and the silicious stones composing the hearth.

The consumption of coal in the form of coke varies with the description of refinery, quality of coke, and the degree of decarbonation effected. In the running-in fire working forge iron, the consumption of a dense coke prepared from bituminous coal will be about 4 cwts. to the ton of metal made: with gray iron the consumption will rise to about 5 cwts. In the melting down refinery the consumption will be about 6½ and 8 cwts. respectively. If the coke is of a weak friable character and of an inferior density, the consumption will be much higher; and with such coke the waste of crude iron in the process will also be augmented.

The consumption of blast is low if compared with the consumption at the blast furnace, but is sufficiently high for the perfect combustion of the fuel charged, and the oxidizement of the carbon and other alloys. Refining forge iron it is about 94,000 cubic

feet per ton of metal produced; by weight it amounts to 7076 lbs., containing 1648 lbs. of oxygen, which is absorbed thus:—

Combustion of the 430 lbs. of carbon in the coke	1146.4 lbs.
Decarbonation of the crude iron . . .	122.4 "
Formation of the protoxide of iron of the cinder	51.8 "
Oxidizement of the silicum	24.8 "
" aluminum	11.9 "
Wasted during the process	290.7 "

or, 17 per cent. of the consumption.

With gray iron the consumption of blast is augmented in nearly the same ratio as the consumption of carbon. In the melting-down fires the consumption is still larger, being with forge qualities 136,000, and for gray qualities 153,000 cubic feet. The density of the blast employed is generally equal to that generated for the blast furnaces in the same establishment. Refineries are worked with a pressure of 1½ lbs. to the square inch, but this may be taken as a minimum density, from 2 to 2½ lbs. being more common. The qualities of the fuel require to be taken into consideration here, as well as in the blast furnace, in proportioning the density of the blast; a weak coke carrying a lower blast than one of a denser structure. But the range of pressure in refineries is not so great as in furnaces. The blast being directed to the surface of the metal in the hearth of the finery, an excessive pressure is attended with a greater oxidizement and consequent loss of metal. Hence, the refiner prefers a blast of 2 to 2½ lbs. to the inch, as being more conducive to a high economy of iron and fuel.

The weekly production of refined plate metal from a running-in refinery is nearly the same as the weekly make of crude iron from blast furnaces in the same district. It has increased and kept pace with the increased make of the furnace, so that from 25 to 30 tons—the make with single fires at the beginning of the present century—it has increased to 150 and 160 tons with the present double refineries. The make of a melting-down refinery at the present day will range from 80 to 100 tons weekly; but if working on all gray iron it will not generally exceed 80 tons, and this, by using old castings of considerable bulk, may be brought down to about 50 tons. But the refineries are under blast only five days weekly; consequently, during the time which they are working, they produce refined plate metal much faster than the blast furnace can supply the necessary crude iron.

Section XVI.—Converting Cast into Malleable Iron.

puddling, and the operations of the forge.

In converting the crude iron of the blast furnace into malleable iron bars in the large way, two modes of procedure are open to the manufacturer,—by refining the crude iron in the refining furnace and then passing it through the puddling process; or, as

is sometimes followed, by pasing the crude iron direct through a modification of the puddling process understood in the manufacture as "boiling pigs." Each method possesses certain advantages, but where quality is the primary consideration, refining and puddling is entitled to the preference. We may, however, here state that the merits of the two systems is a subject on which iron-masters generally do not agree; by some the boiling process is held to be fully equal, and more economical than the refining and puddling; on the other hand it is maintained, with some reason, that the boiled iron is more inclined to the red-short quality than iron otherwise prepared. In several works both methods may be seen in operation, but where this has occurred we have noticed that the largest quantity of iron is first passed through the refinery. Hence, in such instances it would appear, that boiling a certain quantity of pigs is considered to be advantageous, but the manufacture of the entire quantity of crude iron in this way is not so advantageous.

We are of opinion, that boiling may be practised to a limited extent with most irons, though more applicable to some than others. Before, however, entering into the merits, of the respective systems, we will describe the furnace employed and the process itself, as followed at the majority of the large Welsh works.

BOILING FURNACE.

The furnace for boiling pigs is constructed with an outside framework of cast iron plates, about 12 feet long, 5½ feet wide inside, and 6 feet high; of the height 9 or 10 inches will be below the floor line of the forge. At one end the plates are bolted to the iron framing carrying the chimney, at the other end to a cross plate of lesser depth, below which an ash-pit is constructed 2 feet deep, and of nearly the same length and breadth as the iron framework. The fireplace is usually of such size that the area of the firegrate shall be from 8 to 12 superficial feet, according to the qualities of the coal to be used. At three or four inches above the level of the grate-bearing bars, there is fixed a cast iron plate about 2½ inches thick, of nearly the same width as the distance between the side plates and in length from the fireplace to the stack framing, supported at short intervals by stout bearing bars, resting on angle pieces bolted to the side plates. On this plate which is called "the bottom," a fire brick furnace is built, width about 3 feet 9 inches at fire end, and parallel for about three-fifths of the length, when it begins to contract, and the stack end is diminished to 16 or 18 inches. The height of the arched roof above the bottom at the fire end is about 27 inches; generally it falls throughout its entire length, but in all cases a sharp descent occurs close to the stack, where the under side of the roof in the narrow flue is brought down to within 10 inches of the level of the bottom; from

this point it is carried level for 9 or 10 inches to the junction of the vertical flue of the chimney stack.

The length of the fireplace having been determined, a brick bridge 14 or 15 inches thick is built on the extreme end of the bottom plate, and carried up to within 10 or 14 inches of the roof. At the stack end, where the furnace is contracted to the narrowest dimension, a second bridge of fire brick about 9 inches in thickness, and 10 to 12 inches in height, is built to restrain the metal from flowing into the flue. When finished, the body of the furnace measures about 6 feet in length, 3 feet 9 inches in width, by 2 feet in height to the roof at the centre. In one side a doorway about 16 inches square is provided for charging and working the crude iron. The height of the bottom of this doorway above the bottom plate is a dimension of some importance. The average height of several works is 10 inches, the lowest being 8, and the highest 11 inches. As the height of this doorway is determined before casting the side plates, it regulates the height of the bottom, and also the roof of the furnace,—especially the latter at the end adjoining the stack, where the general rule is to have the under side of the arch level with the lower side of the doorway.

The metal forming the lower edge of the doorway is subject to abrasion by the working bars of the puddler; to increase its durability a loose plate about 1½ inches thick is bolted on it, for facility of renewal. The cast iron door is lined on the inside with fire brick, and slides up and down between strong cast iron flanches by a rod connected to a lever having a balance weight at the other end. For the convenience of working and for the protection of the puddler from the intense heat, a small notch about 3½ by 4½ inches high is left in the under side of the door; through this the working operations are principally carried on. To prevent the sides and upper edge from enlarging by wear, the metal around is hardened by being cast with metal chills. This, the working door, is situated rather nearer the fire bridge than flue. In the wall thus left on the flue side, a second doorway of smaller dimensions than the other is left for charging the metal, where this is done before the previous heat has been withdrawn. This charging door is usually about 10 by 13 inches wide, and 12 or 18 inches from the bottom plate, having a lever and balance weight for lifting similar to the other. They are used in boiling furnaces, though a single door often suffices; in puddling, however, they are very generally adopted.

A doorway about 10 by 10 inches is also left opposite the fire place; it has a cast iron mouthpiece but no door, the mode of firing rendering this unnecessary. At the stack end a small flue about 4 by 6 inches is provided for the escape of any cinder that may pass over the bridge into the flue: to keep it open for the passage of the cinder, and to maintain the latter sufficiently fluid,

a small fire is kept burning over it in a grate secured to the outside frame of the stack.

The chimney stack is built of fire brick, and for the majority of forge coals requires to be 30 feet above the cast iron framework at bottom, or 36 feet altogether. The interior flue is made about 24 inches square, but at the junction with the roof of the furnace it is contracted to about one-third of this area. This contraction is regulated, partly by the skill of the operative and quality of metal under operation, but principally by the qualities of the coal employed. We have seen the area contracted to 17 by 9 inches, with a coal approaching nearly to the character of anthracite: with a more inflammable coal it has been 18 by 18 inches. The chimney walls are usually built 1½ brick thick for about 14 feet, 1 brick for 10 feet, and ½ brick the remaining 6 feet. The intense heat destroys the interior of the lower courses in a comparatively short period; to facilitate the renewal of the portion thus frequently destroyed, for about 20 feet high a half-brick thickness of lining is carried up without bonding with the other work, as represented in the sectional elevation of puddling furnace, Plate 9; when necessary it is drawn down and rebuilt, without endangering the general stability of the stack.

The top is surmounted with a light cast iron framework, having a damper for regulating the draught. The damper is opened and shut by a lever, from which an iron rod or chain descends on the outside to the workmen below. A different mode of regulating the draught is sometimes adopted; but of its action we shall have farther occasion to speak.

The effects of the expansion and contraction of the brickwork by the alternate heating and cooling, is provided for by numerous iron binders built in the brickwork, the projecting ends punched or cast to receive vertical wrought rods, which are forced tight against the brickwork by iron wedges at the back. Unless well bound together, the light chimney stacks cannot long stand in a vertical position under the alternate straining to which the brickwork is subjected. Imperfectly bound stacks may be seen in every work, inclining at angles more or less dangerous to their stability. The stack delineated in Plate 9 is bound with more than 200 separate pieces of wrought and cast iron.

The immense strain exerted by the expansion of the brickwork of the roof, has also to be met by a system of binding, consisting of strong wrought iron bolts, at the top and bottom of the side plates. For ordinary furnaces they should be not more than 2 feet 6 inches apart, when the bolts are 1½ inches square. The plates also may be largely strengthened by vertical ribs on the outside face, diminishing thereby the risk of fracture—a too frequent occurrence. In some works, Cyfarthfa, for instance, the binding is composed of wrought iron looped straps at top and bottom, with vertical connecting bolts also of wrought iron; by this

arrangement, the direct strain on the side plates is greatly reduced, and their durability consequently increased. The plate in which the doorway for feeding the fire is situated, commonly called the stock hole plate, is the least durable of the whole. The stock hole is usually a square with sharp angles; after a few weeks, at other times only a few days, the plate breaks across one or more of the angles. This is doubtless caused by the unequal expansion and contraction of the surface, but a remedy has not been discovered. The angles have been rounded off without effect; in other cases wrought iron looped clamps have been cast in the metal across and at right angles to the general direction of the fracture, but without adding greatly to the durability.

THE BOILING PROCESS.

The bottom plate is covered with broken cinders from previous workings, and mill scales, and a fire lit in the grate. In from 10 to 12 hours with new furnaces, but generally 5 or 6 suffices with old, the interior of the furnace approaches a white heat; the cinders melt, and flowing over the bottom protects it from the fused iron and intense reverberatory action of the roof, and fills any crevices in the edge of the brick lining; the draught is slightly diminished; about 30 or 40 lbs. of cinders are charged at the flue end; and the quantity of pigs to be operated on, technically termed a "charge," in convenient size pieces, 30 or 40 lbs. is best, and the more uniform in size the better. A charge weighs from $3\frac{3}{4}$ to $4\frac{1}{2}$ cwts., according to the quality and local usage. It is distributed on the bottom of the furnace, and closing the various doors, the admission of cold atmospheric air is prevented by throwing a small quantity of fine small coal or cinders around the edges, filling the notch in the door with a lump of coal, and closing with an iron plate. The damper is opened to its full extent, fresh coal is added to the grate, and the fire is otherwise urged to the production of a high temperature. From the peculiar form of the roof, the heated products of combustion on striking against the under side are deflected on the pigs, and the extremity of the roof being placed low they are compelled to pass in close contact with the entire charge.

In 15 or 16 minutes after charging, the operative puddler throws in about 60 or 80 lbs. of the cinder expelled from mill bars as they pass the rolls; where these cannot be obtained, recourse is had to the cinder from rolls rolling puddled iron bars. The cinders drawn from under rolls rolling boiled iron bars are of inferior quality, and never used in the boiling furnace if others can be obtained. They contain a larger percentage of silica and are less fluid, from which circumstance the time occupied in the process is lengthened whenever they are used, and it is believed, with some reason, that the quality of the resulting bar iron is inferior.

ART. II.—ON THE COMBINATION OF CARBON AND IRON, AND THEIR INFLUENCE ON THE PRODUCTION OF PIG IRON.* By A. GUELT.

(Continued from page 47, Vol. VIII.)

AFTER these remarks, it will be as well to consider the somewhat modified theory of the production of cast iron, and to follow a charge from the furnace mouth to the crucible. The charge gradually descending as the furnace becomes heated, arrives at the zone of reduction with a temperature of about 400° C. (750° F.) Here the oxides of iron, manganese, sulphur, and phosphorus are gradually reduced, the electro-negative substances combining the moment they are set free with the electro-positive to form metallic sulphites and phosphurets. After the reduction of all the oxides is effected, which is completed about the junction of the belly with the boshes, the charge, now consisting of metal, phosphurets, and sulphurets, with the materials of the slag, enters the zone of carburation, and comes in contact with a large excess of carbonizing gases—viz., oxide of carbon and cyanogen. By its intimate contact with these carbonizing gases and the carbon of the fuel at the high temperature here existing, the reguline metal existing in the state of soft malleable iron uncombined with any electro-negative body becomes carbonized, that is to say, it unites chemically with carbon, which it abstracts from the carbonic oxide and cyanogen gases proportionately as it sinks deeper in the boshes. In most blast furnaces, however, the boshes are considerably contracted at the base, so that the charge is detained, relatively speaking, sufficiently long in this region to combine with its maximum of carbon, passing into the condition of tetracarburet. In the normal working of the furnace then, there is always one portion of the iron saturated with carbon when it enters the zone of fusion. In the zone of fusion the pig iron and the earthy matters are melted, and sink together through the hottest part of the furnace, the zone of oxidation, into the crucible, where it collects. If now the temperature existing in the zone of fusion and oxidation were not much higher than the point of fusion of the specular iron, the tetracarburet found in the zone of carburation would arrive undecomposed, and solidify after tapping as white cast iron, with little or no graphite. If the charge remained long enough in the zone of carburation to saturate the whole of the iron with carbon, specular iron would be produced. In either case, however, the whole of the carbon exists chemically combined with the iron, with the occasional exception of that small quantity of graphite separated by silicium which is not visible on the fracture. The reduction of the silicium seems to commence

* From the Lond. Chem. Gaz., No. 329.

about the melting-point of specular iron, as it exists in very small quantity in this kind of iron, and in white cast iron produced from easily fusible ores at a low temperature; in gray cast iron, however, which is known to require a much higher temperature and more refractory ores, it exists in much larger quantity. The very considerable difference of temperature which must prevail in the furnace during the preparation of white and gray cast iron, may be judged of from the fact, that with the same ores and fuel the quantity of carbon required to produce gray cast iron will be fifty per cent. greater than is necessary for white cast iron. When, therefore, the temperature of the zones of fusion and oxidation considerably exceeds the melting point of specular iron, which must always be the case in the preparation of gray cast iron, the tetracarburet formed will be decomposed into octocar buret and carbon, separating in the form of graphite. The melted crude iron arrives in the crucible as octocarburet, and solidifies, after casting, into gray cast iron. By incomplete decomposition of the tetracarburet, mottled cast iron is produced, consisting of a mixture of tetracarburet and octocarburet similar to white cast iron, but distinguishable from this by the particles of graphite disseminated through it.

In order to ascertain how far the views expressed above as to the influence exerted by the carburets of iron on the production of pig iron would agree with the results of analysis, the author calculated a series of the most trustworthy analyses of pig iron by Karsten, Berthier, Bodemann, Bromeis, and others. In this calculation, the fundamental principle was adhered to, that all the electro-negative constituents of the cast iron were chemically combined with the electro-positive, according to those known compounds in which the maximum of the latter is contained as $(FeMn)^4P$, $(FeMn)^8$ S, and $(FeMn)^8$ Si. The only exception being in the case of the specular iron, where for the sake of analogy with the carburets, a tetrasiliciuret has been assumed.

The following are the results of the calculation:—

I. White Cast iron.

Specular Iron from Spathose Iron Ore from Saynerhutte.

					Karsten.
Carbon	5·112	Fe^4 C	Fe	94·188	99·300
Sulphur	0·005		C	5·112	
Iron	94·887	Fe^8 S	Fe	0·014	0·015
Copper	trace		S	0·001	
	100·000			99·315	

Specular Iron from Lohhutte.

					Karsten.
Carbon	5.411	Fe^4 C	Fe	88·099	97·291
Silicium	0·366		Mn	4·245	
Sulphur, Phosphorus	traces.		C	4·947	
Iron	90·797	Fe^4 Si	Fe	1·698	2·064
Manganese	4·245		Si	0·366	
Copper	0·179				
	99·998			99·355	

Specular Iron from Spathose and Brown Iron Ores, Hammhutte. Karsten.

Carbon	5·140	$(Fe, Mn)^4C$	Fe	89·726	95·606
Sulphur	0·002		Mn	0·794	
Phosphorus	0·080		C	5·086	
Silicium	0·560	Mn^4Si	Mn	3·130	3·686
Iron	89·720		Si	0·556	
Manganese	4·300	Mn^4P	Mn	0·556	·636
			P	0·080	
		Mn^8S	Mn	0·028	0·030
			S	0·002	
	100·002			99·958	

White Cast Iron, Calder Iron Works, England. Berthier.

Carbon	1·90	Fe^4C+Fe^3C	Fe	53·750	55·671
Graphite	0·50		C	1·921	
Sulphur	1·40	Fe^3Si	Fe	12·108	13·308
Phosphorus	1·20		Si	1·200	
Silicium	1·20	Fe^3S	Fe	19·474	20·874
Iron	93·42		S	1·400	
Manganese	0·38	Fe^4P	Fe	8·088	9·288
			P	1·200	
		Graphite			0·500
	100·00				99·641

White Cast Iron, Hammhutte. Berthier.

Carbon	2·910	Fe^4C+3Fe^3C	Fe	95·202	98·112
Sulphur	0·010		C	2·910	
Phosphorus	0·080	Mn^3Si	Mn	0·109	0·110
Silicium	0·001		Si	0·001	
Iron	95·202	Mn^3S	Mn	0·140	0·150
Manganese	0·890		S	0·010	
		Mn^4P	Mn	0·528	0·608
			P	0·080	
	99·093			98·980	

White Cast Iron from Spathose Iron Ore, Magdeesprung. Bromeis.

Carbon	2·52	Fe^4C+6Fe^3C	Fe	88·532	91·052
Graphite	0·50		C	2·520	
Sulphur	trace	Fe^3Si	Fe	3·329	3·659
Phosphorus	0·40		Si	0·330	
Silicium	0·33	Mn^4P	Mn	3·270	3·670
Iron	92·06		P	0·400	
Manganese	3·27	Graphite			0·610
Copper	0·11	Copper			
	99·19				8·991

II. Gray Cast Iron.

Mottled Cast Iron from Sphærosiderite, Firmy. Berthier.

Carbon	1·00	$2Fe^4C+Fe^3C$	Fe	24·84	25·84
Graphite	0.18		C	1·00	
Sulphur	3·75	Fe^3Si	Fe	13·11	14·41
Phosphorus	0·38		Si	1.30	
Silicium	1·30	Fe^3S	Fe	52·36	56·11
Iron	93·99		S	3·75	
		Fe^4P	Fe	2·56	2.94
			P	0·38	
		Graphite			0·18
	100·00				99·48

Mottled Cast Iron from Konigshutte, Harts. Bodemann.

Carbon	2·78	Fe^4 C+Fe^3 C	Fe	77·562	80·342
Graphite	1·99		C	2.780	
Phosphorus	1·23	Fe^3 Si	Fe	7·164	7·874
Sulphur	trace		Si	0·710	
Silicium	0·71	Fe^4 P	Fe	0·290	9·520
Iron	93·29		P	1.230	
		Graphite			1·990
	100·00				99.726

Mottled Cast Iron, South Staffordshire. Wrightson.

Carbon	2·72	Fe^4 C+Fe^3 C	Fe	91·310	94·030
Graphite	0·26		C	2·720	
Phosphorus	0·37	Fe^3 Si	Fe	1·109	1.219
Sulphur	trace		Si	0·110	
Silicium	0·11	Fe^4 P	Fe	2·493	2·863
Iron	95·80		P	0·370	
		Graphite			0·260
Manganese, Calcium, Sodium,	0·74	Mn Ca Na			0·740
	100·00				99·112

Gray Pig Iron, Konigshutte, Harts. Bodemann.

Carbon	1·44	Fe^3 C	Fe	53.726	55·166
Graphite	2·71		C	1·440	
Sulphur	trace	Fe^3 Si	Fe	32·388	35·598
Phosphorus	1·22		Si	3·210	
Silicium	3·21	Fe^4 P	Fe	8·223	9·443
Iron	92·42		P	1·220	
		Graphite			2·710
	101·00				102·917

Gray Cast Iron from Spathose and Brown Iron Ores, Hammhutte. Karsten.

Carbon	2·08	$(Fe, Mn)^3$ C	Fe Mn	78·70	80·78
Graphite	2·87		C	2·08	
Silicium	1·81	Fe^3 Si	Fe	13·14	14·45
Phosphorus	0·08		Si	1·31	
Iron	86·73	Fe^4 P	Fe	0·75	0 83
Manganese	7·42		P	00·8	
		Graphite			2·87
	99·99				98·43

Gray Iron from Lancashire Hæmatite. Miller.

Carbon	2·217	Fe^3 C	Fe	82·716	84 933
Graphite	0 538		C	2 217	
Silicium	0·951	Fe^3 Si	Fe	9·5·5	10·546
Sulphur	0·150		Si	0·951	
Phosphorus	trace	Fe^3 S	Fe	2·086	2·236
Iron	95·777		S	0·150	
		Graphite			0·538
	99·638				98·253

A glance at the interpretation of the above analyses will be sufficient to show the close agreement between the results assuming the hypothesis of the two sub-carburets of iron, and to prove the probable correctness of the views on the theory of the production of pig iron above put forth.

Lastly, to exhibit analytically the influence which the different temperatures at which the respective varieties of cast iron are produced exert on their composition, the author undertook a series of analyses of such varieties of pig iron as were produced from the same ores, fluxes, and fuel, but at different degrees of temperature. These were five varieties from the celebrated iron works of Gartsherrie in Scotland, made from black band ironstone with raw coal and limestone from the coal measures. Their chemical composition was as follows:—

	1.	2.	3.	4.	5.
Carbon	1·347	1·021	1·793	1·925	2·451
Graphite	3·156	2·641	1·110	1·051	0·877
Silicium	2·721	3·061	2·165	1·895	1·124
Sulphur	1·267	1·139	1·480	1·614	2·516
Phosphorus	0·842	0·928	1·171	1·811	0·918
Iron.	88·983	90·236	89·314	91·368	89·863
Manganese	2·401	0·834	1·596	0·571	2·175
	100·717	99·860	98·629	100·235	100·459

1. Very gray iron, with graphite in large flakes; spec. grav.=7·15.
2. Gray iron with much graphite, but in small flakes; spec. grav.=7·21.
3. Mottled gray iron; spec. grav.=7·21.
4. Mottled gray iron; spec. grav.=7·25.
5. White cast iron, with radiate crystalline fracture; spec. grav.=7·41.

Of these pig irons 1 and 2 were produced at the highest temperature, that is to say, with the largest consumption of fuel, while in the three others it was diminished. The blast had a considerable pressure, and the air was heated above the melting point of lead for the production of the gray pig.

The above analyses plainly show, that with the diminution of the temperature the amount of the graphite and the silicium also diminishes, and, on the other hand, that the chemically-combined carbon and the sulphur steadily increase, while the amount of phosphorus varies; for the amount of manganese also no law can be discovered. The large amount of sulphur in these Scotch irons is, no doubt, chiefly owing to a considerable quantity of pyrites often disseminated through the coal used as fuel.

The theoretical calculation of the five analyses agrees with the above assumption, that the two varieties 1 and 2 are composed of $Fe^3 C$, and the three others of mixtures of $Fe^3 C$ and $Fe^4 C$, furnishing a new proof of the correctness of the above views on the influence exerted by the carburets of iron on the chemical composition of pig iron.

On the Analysis of Cast Iron.—As the analysis of cast iron is often accompanied with considerable difficulty, and the various methods proposed afford results differing widely from each other, the author gives the following methods made use of by himse after many comparative trials had convinced him of their advantage and accuracy.

Determination of the Carbon, Graphite, and Silicium.—The substance is placed in a glass flask, with about four times its weight of chloride of silver recently precipitated and well washed, a saturated solution of muriate of ammonia poured over it, and allowed to stand ten to twelve days at a moderate temperature. The iron is hereby converted into protochloride and dissolved, but is again decomposed into sesquioxide and sesquichloride by absorption of oxygen. The silicium is oxidized, and the carbon and graphite remain undissolved. When the iron is completely dissolved, the solution is gently boiled with a few drops of hydrochloric acid to redissolve any portions of sesquioxide which may have separated, the contents of the flask are then brought on a filter, and the residue washed first with water, and afterwards with cyanide of potassium, to dissolve any undecomposed chloride of silver; this must be continued until the filtered fluid no longer exhibits the reactions of silver; the washing is then completed with pure water, and the filter dried and weighed; the weight of the silver, graphite, carbon and silica is thus obtained; a certain portion of this residue is then boiled for some time with a solution of caustic soda; the silica and chemically combined carbon are dissolved and separated from the silver and graphite, which are weighed, and the difference will give the weight of the former substances.

The solution of soda is evaporated to dryness after being acidulated with hydrochloric acid, redissolved and filtered; the carbon and silica remain on the filter, which is burnt; the weight of the silica is thus obtained, that of the carbon being determined by the difference.

To determine the graphite, it is only necessary to dissolve the silver in dilute nitric acid; the graphite remains unaltered and may be weighed.

Determination of the Sulphur.—It is not advisable to determine the sulphur in cast iron by precipitating the sulphuric acid by a salt of baryta from a solution in aqua regia, as it is difficult to avoid a portion of nitrate of baryta accompanying the precipitate, which cannot afterwards be separated by washing. It is better to dissolve about 1 grm. of the iron in dilute sulphuric acid with the assistance of heat, passing the hydrosulphuric acid gas into a moderately dilute solution of acetate of lead. The sulphuret of lead thereby produced is collected on a filter, well washed, converted into sulphate of lead by means of nitric acid, and weighed.

Determination of Iron, Manganese, and Phosphorus.—From a solution of the iron in aqua regia, in which these substances will exist as chloride of iron, protochloride of manganese, and phosphoric acid, the iron is precipitated by the addition of pure dry carbonate of soda in the cold, accompanied by the phosphoric acid as phosphate of iron, while the manganese remains in solu-

tion as carbonate of protoxide of manganese dissolved by the excess of carbonic acid. The precipitate is collected without loss of time, and thoroughly washed with cold water; it is ignited and weighed, and gives the amount of iron and phosphoric acid. A weighed portion of this precipitate is fused with four times its weight of a mixture of 3 $NaO\,CO^2$+2KO CO^2, for twenty to thirty minutes, in a platinum crucible, whereby the phosphoric acid is brought into combination with soda; the fused mass is treated with water and filtered, the solution saturated with pure nitric acid, and boiled some time to expel the whole of the carbonic acid; a few drops of acetic acid and solution of acetate of lead are then added, whereupon phosphate of lead is precipitated, which is washed and ignited; it contains in 100 parts, 8·523 of phosphorus. The manganese is easily obtained from the solution in carbonic acid by the addition of caustic soda or potash; the precipitate, which is white, but gradually becomes brown, is collected, ignited, and weighed as deutoxide.

Determination of Zinc.—In some specimens of cast iron minute quantities of zinc are found, which can only be estimated by a separate experiment. From a solution in aqua regia the iron is precipitated by succinate of soda, afterwards the zinc by carbonate of soda; the manganese remains in solution; the carbonate of zinc is ignited, and weighed as oxide of zinc.

Determination of Arsenic and Copper.—Arsenic and copper are precipitated by hydrosulphuric acid from the solution of the iron in aqua regia, separated from each other by sulphide of ammonium, and determined in the usual manner.—*Polytechn. Centralbl.*, 1856, p. 366–379.

Art. III.—EXPERIENCE OF THE GOLD MINES OF CALIFORNIA.

(Continued from page 40 Vol. VIII.)

EMPIRE MINE, GRASS VALLEY, NEVADA COUNTY.

The reductions of this Company are situated in the town of Grass Valley.

The lodes, which constitute this mine, are situated one upon Ophir Hill and another upon the hill known as the Ben Franklin, and about one and a half miles east of the town.

The Company commenced its operation in 1852, and have continued almost uninterruptedly since that year, or more particularly so from the early part of 1853.

Most of the workings during 1853 were of the superficial character that was so general throughout the State in this depart-

ment of mining, owing to the then prevailing idea that was promulgated by pretenders, that the lodes would, in all probability, give out at small depths below the surface.

In the latter part of 1854, the Company, like their neighbors of Osborn Hill, commenced their first permanent improvements. This was done by sinking a large whim shaft to the depth of seventeen fathoms, and the driving of a series of adits and levels from the bottom of the shaft.

The opening consisted in driving what are known as the east and west levels, which are one hundred and twenty feet apart.

The west level was driven north of the main shaft three hundred and twenty feet, and south of the same one hundred and forty feet; and the east level corresponding to the former.

Between the levels and south of the shaft two winzes of one hundred and twenty feet each were driven, and north of the shaft another winze of the same length and which extended east of the east level sixty feet, connecting with another smaller level which had been driven to the length of ninety feet; a winze, one hundred and eighty feet was also carried to the depth of thirty-five feet between the east and west galleries, and was subsequently carried entirely through to the depth of one hundred and twenty feet.

The mine was, therefore, divided into six compartments of about one hundred feet square, and all connected directly with the main shaft, affording easy communication with the surface and the advantage of uninterrupted workings in all parts of the mine.

During 1855, a large proportion of this ore was sloped out and reduced, and at the time I visited the mine the Company had commenced opening another level one hundred and seven feet west of the engine shaft, and had made a cross-cut seventy-six feet in length.

On the Ben Franklin lode an adit had been driven one hundred and seventy feet, at which point the vein was cut, [and a level was being driven to the south, which, in December, had attained the length of thirty-five feet. A considerable body of ore had been delivered to the surface, having many of the characteristics of Ophir Hill.

The character of the ores of this lode are such, that the gold which it contains, is in a free state, owing to the extensive decomposition of the pyritous elements originally contained within it. There are some portions, however, which require calcination, in order to liberate the metal. The depth of seventeen fathoms has not been sufficient to produce a solid wall to the lode, though all the mines which have opened in this vicinity have presented this ture usually at about half that depth.

From the position of the greenstone, it is highly probable that a few feet below their present workings, this rock will be met, as in the adjacent country.

The following statistics will give the operations of this mine for 1854 and 1855:

STATISTICS FOR 1854.

Number of men employed, thirty-six.	
20 Miners, $5 per day	$2,400
6 Stokers, $4 "	576
2 Engineers, mine	200
2 " mill	260
2 Battery tenders	180
2 Shaft Stokers	120
1 Amalgamator	130
1 Carpenter	130
1 Blacksmith	130
4 Cords wood per day, at $4 50 per cord	432
Teaming $ 25 per day	600
Total	$5,158
Sinking Engine Shaft	1,500
Aggregate expenses for 10 months	51,580
Dead work	1,500
Total expenses	$53,080
Aggregate ore reduced 5,000 tons	
Aggregate value ore reduced	130,000
Balance in favor	$76,120

STATISTICS FOR 1855.

Number of men employed, thirty-eight.	
21 Miners, at $4 per day	$2,184
6 Stokers	432
2 Engineers, mine	180
2 " mill	200
2 Battery tenders	180
2 Shaft Stokers	120
1 Amalgamator	100
1 Carpenter	100
1 Blacksmith	100
4 Cords wood per day, $3 per cord	288
Teaming	500
Incidentals	500
Total	$4,884
Aggregate expenses for 9 months	$43,884
Dead work	2,000
Total expenses	$45,884
Aggregate ore reduced, 4,680 tons.	
Aggregate value, at $25 per ton	116,000
Balance in favor	$70,000

In regard to the figures given, touching the valuation of ores not only of this mine but those of several others, I will state that

I am fully aware that they are actually below what they have averaged for months consecutively; and in these statements I prefer to err by being below the absolute yield, than to commit an error in being above their value.

My object and aim in these statements has been to place the results of these adventures before the public in such a form, as will have a tendency to convey a more lucid idea of the probabilities of success or failure in this branch of employment. In giving these figures, it may be that I have overstepped the bounds of prudence, and perhaps, to some extent, the confidence of those who have from time to time furnished me with the statistics of their operations; and if so, my only apology for so doing is, that we have arrived at that period in our history when it has become incumbent upon us to demonstrate the practicability or impracticability of operations of this kind within this State, and to divest the business, as much as possible, of either the suspicion that rests upon it, arising from the precedents of gold-mining in other States and countries, or, the surmises of success or failure, by which it is at present encompassed.

Original capital paid in (cash)	$32,000
Nominal capital	600,000

Month of August, one dividend on nominal capital, 1 per cent.
" September, " " " ½ " "
" October, " " " ½ " "

HELVETIA AND LAFAYETTE MINE, LAFAYETTE HILL, GRASS VALLEY, NEVADA COUNTY.

The above mine was located in 1851, and soon after its location the Company commenced operations in the opening of their lode. It was not, however, until the early part of 1852 that any considerable amount of excavation was made; and it is from this period that the mine should date its beginning.

During the general crash that befell most of the *gold mines* in that year, this Company pursued a uniform and continued course of working throughout the panic, and carried their operations through, almost uninterrupted, up to the present date. It is therefore one of the oldest established mines in the State, and ranks one of the first among the pioneers of gold-mining in California.

From the first opening of the lode on Lafayette Hill, up to the close of 1855, the reduction works of the mine were situated nearly two miles from their vein; they have, consequently, been subjected to a heavy expense in transporting their ores to the mill. During 1855 they have erected a new and capacious mill directly upon their lode, the machinery of the reduction works doing nearly all the labor of hoisting of ores, pumping, etc., that had previously been done by hand, on the mine.

During the years 1852 and 1853 the workings on the lode at Lafayette Hill consisted in the following amounts:

An adit was carried from the north side of the hill to the length of two hundred feet, and from the end of this a level was commenced and driven on the vein to the length of eleven hundred feet, at an average depth of nine fathoms below the surface. On the strike of the vein some eight shafts were sunk, four of which were nine fathoms, three eleven fathoms, and one thirteen fathoms; each of these shafts was supplied with a hand-windlass, and from most of them ores were delivered to the surface alternately.

After the level had been carried through, and a connection formed with the surface by means of the adit, the shaft delivery of ores was abandoned, and the mineral matter taken to the surface by the latter means. During 1854 all the ores were taken out by this channel on train-ways laid for the purpose.

During 1854 the underground workings consisted in breasting down the lode for nearly its entire length, which was carried to the depth of seven fathoms. The walls of the lode being for the best nine fathoms, a very compact and hard greenstone trap, the lode and walls requiring blasting every foot that was excavated.

During the year 1855 the Company have completed the erection of their new mill, as above mentioned, and the subterranean workings to connect with it, are as follows:

From the end of the adit a heavy cross-cut has been carried northward forty-six feet, at an average expense of forty dollars per foot; at the end of this a shaft (engine shaft) six feet by eight, has been sunk to the depth of fifteen fathoms, heavily timbered and planked throughout. The cross-cut connects with the 1,100 feet level, and thus easy and efficient communication is established with the surface of the mine throughout.

From the bottom of the engine shaft a level is to be driven during the coming year, the end of which is to be equal to that of the main level of 1,100 feet, and at its completion a body of ore will be placed in position to be sloped down, having an average depth of twenty-eight fathoms below the present line of workings. This, it will be seen, will afford facilities for obtaining ore to any amount that may be desired for at least three years to come.

The reduction of ores during the past year, have not been as extensive as formerly, from the fact of heavy and costly improvements going on, and the desire to avoid the burdensome expense of the transportation of ores to such a long distance. This expense will be entirely saved during the coming year, and will materially increase the net receipts to an amount little short of $11,000.

The greatest depth attained in the lode, at the close of 1855, was twenty-four fathoms; at this point the vein carries a power of four feet. At this depth there appears to be a material change

in the mineral character of the ore from that of the preceding yea with the exception, perhaps, of a slight increase of the arsenic sulphurets, but even this is questionable.

Lead and a small quantity of molybdenum, with occasiona traces of zinc as formerly, are among the products of the ore.

The following statistics will furnish some additional informa tion of the operations of this mine, and also its present workin condition:

STATISTICS FOR 1854.

Number of men employed, twenty-four.	
16 Miners, at $100	$1,600
2 Engineers, $125	250
1 Battery tenders at $100	2(
2 Stokers, at $75	15(
1 Blacksmith	1[illegible]
1 Carpenter	1[illegible]
2½ Cords wood $4 50	2[illegible]
Teaming, $30 per day	1[illegible]
Incidentals	65(
	$3,5[illegible]
Aggregate ore reduced in eight months, 4,160 tons.	
Average yield, at $18 per ton	$74,880
Amount dead work	6,450
Total receipts	$74,880
Total expenses	42,348
Balance	$32,532

STATISTICS FOR 1855.

Number of men employed, forty-five.	
34 Miners, at $80	$2,720
2 Engineers, at $125	250
2 Battery Tenders	200
4 Stokers, at $55	220
1 Blacksmith	125
1 Carpenter	125
2½ cords Wood, at $3	195
Teaming, $30 per day	780
Incidentals	650
	$5,265
Aggregate ore reduced in eight months, 4,000 tons.	
Average yield, at $25 per ton	$100,000
Dead work on mine	30,000
Cost of Mill	20,000
Total receipts	$100,000
Total expenses	92,120
Balance	7,880

Below will be found a recapitulation of the condition of the mine on t 1st of January, 1856.

RECAPITULATION.

	Feet.
1 Adit	200
1 Level	1,100

	Fathoms.
4 shafts each	9
3 "	11
1 "	13
1 engine shaft	15
1 air shaft	12
Total	60

Strike, east and west; dip, north 41°. Power, four feet.
Working fourteen fathoms below water line.

MOUNT WASHINGTON MINE, FRENCH GULCH, SHASTA COUNTY.

In the northern part of the State this Company were pioneers in this branch of industry. The mine and reduction works are situated on French Gulch, about two miles from the town, and on the Shasta and Yreka Roads.

Simultaneous with many of the openings made in the early part of 1852, in the middle and south part of the State, this Company located and opened their lode in this region. During that year and the subsequent one, a considerable amount of loss was sustained in their operations, arising from the unsystematic methods adopted in working. The lode was found to be valuable, and the utmost confidence was reposed in its productions, but the necessity of a radical change in the conduction of their operations became apparent to all concerned, in order to insure success and profit from their property.

Accordingly a new directorship was the first result of the above conclusion, and which saved the mine literally from total abandonment.

On the advent of the new administration the mine was heavily involved, but by the month of September, 1853, the entire liabilities were discharged from the proceeds of the mine, over and above expenses. During that year the Company drove an adit at an expense of $1,800, which was 130 feet in length, and opened a line of level together with the adit, which amounted in their aggregate to nearly 300 feet. During the latter part of 1853, and to the close of the year ending August, 1854, they had expended in improvements on the mine, $1,080 additional, in placing the workings in a stable condition.

The employees upon the mine during the latter period averaged nine men for each month during the year, at an aggregate expense of $1,360 per month, inclusive of board; and the incidental expenses amounted to about $175 per month additional.

The receipts from the mine during the same period were as follows:

September, 1853		$7,341 20
October,	"	5,012 00
November,	"	4,508 58

December, 1853	$3,262 80
January, 1854	5,246 40
February, "	4,170 20
March, "	6,777 20
April, "	5,420 45
May, "	3,280 40
June, "	2,618 80
July, "	2,594 40
August, "	3,000 00
	$53,232 43
Cash capital	$7,000
Expenses for year	16,320
Dead Work	2,880
Receipts	$53,232 43
Expenses	19,200 00
Balance	$34,032 43

From the above statement it will be observed, that from May to August there is a diminution in the monthly receipts. This occurred from the failure of water during those four months to that extent that not over one-half running time was actually made, the water for the motive power being derived from the creek on which the mine is situated.

The lode is situated superiorly in slates, and inferiorly in the trap rock. The ores are peculiar, and differ somewhat in their general appearance from most of the ores of other mines. The attendant metallic compounds are lead, molybdenum, arsenic, iron, and a small quantity of copper, all in the form of sulphurets, but much more intimately blended than is usual in other parts of the State. Associated with these is metallic gold, easily visible, but more commonly invested by its associated minerals. It is probable that a considerable percentage of silver abounds in these ores, though no absolute experiment has as yet been instituted to ascertain that fact. The following is the present condition of the mine and its workings, with expenditures and receipts for 1855:

Since the latter part of 1854, an adit has been driven two hundred and twenty feet, which cuts the main lode ninety feet from the surface. The upper levels have been driven to the length of five hundred and twenty-two feet, and from the western end of the latter an inclined shaft has been driven on the lode to the depth of thirty-two fathoms. In the course of driving on the lower adit of two hundred and fifty feet, several beds of ore, amounting to twelve feet in thickness, were driven through, each containing gold, but insufficient to warrant its extraction in preference to the main lode.

The train-way from the mouth of the mine to the reduction works has been completed, and is three-fourths of a mile in length. It is carried over two inclines of eight hundred and twenty-seven feet in length each, and has cost for its completion, $5,400. The

running time for 1855 has amounted to eight months only, the balance of the year being lost from insufficiency of water for power in part, and necessary improvements.

RECAPITULATION.

Number of men employed, 12.

3 Miners,	$90	per month	$270
2 Battery tenders,	$60	per month	120
1 Superintendent,	$150	per month	150
4 Stokers,	50	"	200
1 Blacksmith,	70	"	70
1 Cook,	60	"	60
Incidentals,	50	"	50
			$920

Ore reduced per month, 117 tons. Average value, $24 62 per ton.
Aggregate ore reduced for eight months, 936 tons. Aggregate value, $22,-132.

Dead Work	$6,090
General Expenses	7,360
	$13,450
Balance in favor	$8,682

CONDITION OF MINE WORKS.

	Feet.
1 Level	522
1 Level	222
1 Level	97
Total Levels	841
	Fathoms.
1 Shaft	30
1 Shaft	12
1 Shaft	23
Total Shafts	66

Depth below water line, twenty-two fathoms.

MARBLE SPRING MINE.

This mine is situated on a branch of the North Fork of the Merced River, in Mariposa County, and the highly metalliferous character of the quartz and the uniformity of its yield in gold, render it one of the most interesting of the quartz mines of California.

The ore is a grayish blue quartz, very hard and solid, containing large quantities of sulphurets of iron, zinc and lead, the latter predominating. From ten to twenty per cent. of the ore consists of sulphurets. The gold yielded is of a low degree of fineness, averaging over 790.1000, and giving so great a proportion of silver, that taken in connection with the argentiferous galena produced, and the general appearance of the ore, it is not unlikely

that the mine may, when more extensively and deeply worked, prove to be a silver mine; it now bears all the appearance of what the Mexicans call *oroche.*

The mine was discovered and located in the summer or fall of 1851, by Silcott, Bunyon, McPhane, Harvey, Humphries and Davenport, and by them sold to the Empire State Quartz Mining Company. New claims have been located in continuation of the same vein by the present proprietors, and it is now claimed by them to the extent of about 1,760 yards.

The general course of the vein is nearly north and south, passing along the back of a ridge of high hills, along whose base, upon one side, flows the Marble Spring Creek, and upon the other, the North Fork of the Merced.

The vein lies between trap rock upon the upper side and slate on the lower, and all the ore is obtained by blasting. It stands at an angle of about fifty degrees, and has kept an average width of two to three feet, and increasing in breadth downward.

The advantageous position of the vein has rendered it unnecessary to sink shafts. Four tunnels have been run in, each twenty to twenty-five feet perpendicular height the one above the other, and starting at the base of the hill and continuing upon and in the direction of the vein, northerly. Their respective lengths, commencing at the lowermost, are three hundred and fifty, two hundred and fifty, two hundred and one hundred feet. They have been opened up, one into the other, and the trap rock taken from above the vein has been used to stow away in the place of the quartz taken out, leaving the tunnels about six feet high and five feet wide, for the conveyance of the ore from the drifts. The ore is conveyed in cars upon train-ways from each tunnel direct to the mill, which stands within one hundred yards of the mouth of the openings.

The total amount of ore taken out, to the commencement of the present working season, has been 1,300 tons, the whole of which has been reduced without selection, and has yielded $56,197 in gold, being an average of forty-three dollars per ton of 2,000 pounds.

The ore is delivered in the mill at a cost of about five to six dollars per ton. The works at the mines, in addition to the necessary out-buildings, smith-shops, etc., at this time consists of a steam mill, having an engine of fifteen-horse power, running ten stamps of five hundred and thirty pounds each, and capable of reducing to a fine powder ten to fifteen tons of crude ore per day of twenty hours.

The process of collecting the gold consists of blankets, Goddard's Amalgamating Tubs, and lastly, a newly invented riffle box.

The fuel used is pine wood, of which great abundance is found in the immediate vicinity, and is delivered at the mill for four to five dollars per cord.

(To be continued.)

The number of hands required and the wages paid are as follows:

Superintendent of Workmen, per month	$100
" Amalgamating	150
First Engineer	130
Second Engineer	75
Carpenter	60
Teamster	50
2 Stamp Feeders, each $50	100
Cook	50
6 Miners, $80 each	480
	$1,195

In addition to salaries, all the employees are boarded, which costs the establishment about twenty dollars per month for each man.

(To be continued.)

ART. IV.—OUR GLOBE AND THE GEOLOGISTS. By DAVID MUSHET.

THE very name of the science did not exist until it was created by the early members of the Geological Society, patient thinkers, who accumulated facts, and warned their students against the danger of premature theory upon mere infantine foundations; but as facts accumulated, these warnings were unheeded; the tendency of the human mind to theorize and to explain every thing at once out of its own "innate ideas" at length overpowered caution; theory overwhelmed us like a flood, and the fruits of patient and diligent labor have been usurped by a body of fire-eaters, who assume that they have now completed the whole science of geology in perfection. They launch their excommunicating flames at every rebellious disciple who refuses to crown their dogmas with the motto "it is finished," and who still desire to proceed in the philosophical work of interrogating Nature, and dive if possible deeper into her secrets than the Geological Survey of Great Britain. The monotonous repetition in what are called geological papers of the "igneous" and the "glacial" theories, and the perseverance in excluding from any part of the discussion those condemned spirits who refuse to be dragged backwards and forwards between the two favorite extremes of dogma, force always upon my mind the graphic lines of Milton, as personifying the professors of our geological schools and the hapless rebels whom they condemn—

"Thither by harpy-footed furies haled;
At certain revolutions all the damned
Are brought from raging fire to starve in ice—
Immovable, infixed, and frozen round
Periods of time, then hurried back to fire."

In the midst of this irrational tumult, it is indeed gratifying to be relieved by the perusal of a letter which does intelligent and intelligible justice to the "globe which we inherit" and to the laws of its maker, seeking to establish harmony and order in the place of convulsion and discord.

It is nearly three centuries since the first scintillæ, of what we now call geology, were struck into light by the discussion raised by Fracastoro and others on the phenomena of marine shells embodied in the rocks of Italian Alps at great heights above the sea level. The naturalists of the whole of Europe became involved in the discussion, which, as usual, was ranged into two parties, with umpire theorists between. The observers could not resist the conviction that these remains must at one time have actually been covered by the sea. The haters of "new things" maintained they were mere semblances, forms created in the rock, or grown there by a concretion of humors. The theorists, having the fear of Vesuvius and Etna immediately before their eyes, began to think of earthquakes and volcanoes as the only means by which the bottom of the sea could have been lifted mountains high. Meanwhile the knowledge of the strange fact increased by further observation in Italy and out of Italy, through the 17th century, until Leibnitz arose, with the usual felicity of a mathematician, to resolve the difficulty. He boldly taught that the earth, originally a molten bubble, had been shot out of a volcano in the sun; that this child of fire had gradually gained a skin by cooling; that the skin had thickened, and in contraction (strange physics) had compressed the inner fluid, which had broken through and formed depressions and elevations, &c., and out of this fiery waste, in due time, by sufficient cooling, all the beautiful variety of the existing earth and sea had proceeded—a few volcanoes and earthquakes still remaining to give us a significant twinge, and occasionally remind us of the convulsive throes of our original birth.

Mathematicians, habituated to the trammels of rigid demonstration, have supplied philosophy with the greatest amount of extraordinary theory. Like men who have always needed a crutch in their locomotion, they indulge when it is thrown away the utmost eccentricity of mental movement. Meanwhile the observation of facts proceeded in our country. Woodward, Mitchell, Martin, and others, in the last century, patiently observed and established the superposition of strata and of a variety of fossils indicating a variety of period. Werner did much abroad in the classification of rocks, after which the volcanic mania again broke

forth, this time in England, in the person of another mathematician, Dr. Hutton. About the commencement of this century new fields of observation were opened to men of sense. The great invention of puddling and rolling iron by Henry Cort, at the close of the last century, caused immediately an immense development of mining in the carboniferous strata; the canals and tunnelling required in providing new means of transport by water and land increased the number of useful sections. Acting on these new data, the persevering intelligence of Dr. Wm. Smith, who, as an active practical man, had no time for vermicular theories, clearly established the succession of the sedimentary rocks, from the old red sandstone, upwards through the carboniferous group, to the overlying new red and lias. This nucleus of the science of geology was pretty well established and received by the year 1810, soon after which I began to listen to the debates of the learning learned. The Mosaic deluge was at this time very much connected with the formation of the sedimentary strata, and every endeavor was made to make its action fit into the newly ascertained facts. Too young to speak, I perhaps thought the more, when, standing on some hill top with enthusiastic seniors, I listened to disquisitions how the torrents of the great flood had furrowed out the wandering valleys of our coal fields. That the gradual deepening of their branches from table lands, then uniting into deeper valleys, until the whole, joining in one gorge bestrewed with alluvium from the higher grounds, debouched upon some estuary, was the effect of watery action, was plain to a child; but I could never reconcile how it was all effected by one passing flood over consolidated rocks. There was more appearance of the gradual action of slow water upon a softened surface. However, men can only put together such ideas as they have, and, under the strong desire of explaining, so inherent in all, something is learned even by the failure of the attempt to make them fit in the absence of the key.

The next epoch in British geology was the investigation of the strata overlying the carboniferous group. In this Dr. Buckland took the lead, an enthusiast in action, but no fire-eater, in those early days. His discoveries of the tropical animals, of a certain class of measures, is a great geological fact, which will be appreciated when the Vulcanists are extinguished, or, at least sufficiently cooled down to look at the truths disclosed by this fact without their red spectacles. The comparative anatomists and conchologists aided the geologists. Mineralogy, developed by crystallography, accumulated permanent materials beyond the delusive and deluding touch of theory, Dr. Buckland convinced himself that the earlier theories of diluvial action were irreconcilable with the new accumulation of facts, and about this time Sir R. Murchison commenced the completion of the series of our sedimentary deposits, by investigating the fossil succession of the

other side of the carboniferous group, and tracing the organic relics downwards to their lowest antarctic types—another great fact which will be seen in their true value when learned eyes cease to be filled with fire.

In the mean time the disciples of Leibnitz and Hutton were not idle. The observers had ascertained superposition and elevation, and depression of tracts and continents, but they did not teach the *why* and *how*. Playfair, another mathematician, fell into the fire; foreign mathematicians, Poisson among the rest, took him out, and ascertained by the calculus the exact number of millions of years which had been consumed in reducing the surface of the igneous ball to its present temperature. Sir C. Lyell, in this country, flourished as an ardent champion of the fiery age. It then became a tacit arrangement between the two schools that the aquiests, as was indeed necessary, should retain all rocks evincing organic remains, and all those without their saving presence should be delivered to the flames. The globe was comfortably shared between the professors, in an offensive and defensive alliance, each giving the other support against all heretics. Neither to Leibnitz nor his followers did it ever appear to be worth while to explain how fire and water first came to dwell peaceably together. Their antagonism is even a vulgar proverb, but the philosopher is above vulgar considerations. An ocean covering more than three-fifths of its surface, settled down at once without the least disturbance upon a globe of incandescent lava; there were no convulsions, not even the gentlest ebullition. On the contrary, the deeper and nearer the fire the ocean is penetrated, the colder the water is found—a fact the theorists have not yet explained. A few cuticular blotches, or irregular pimples, called volcanoes, scattered at remote distances over the vast surface of the land, were studied by the geological doctors as the vital organs; the anatomy of the terrestrial body was sought for by dissecting carefully these superficial pustules, as exhibiting the energy, the seat, and the laws, of healthy life; a reasonable course, further only to be parallcled with the wisdom of a vegetable physiologist who should profess to explain the processes in the growth of a tree, the formation of wood, bark, leaves, roots, sap, and its absorption of the nutriment, by attention to nothing but the diseased exudations of its gum.

I think we are as much indebted to Sir C. Lyell as to any writer for the reception of this igneous dream. Out of his researches into European volcanoes and their remains are certainly derived the greater part of the evidence, such as it is, which the igneists rely on. But had he attended to the evidence on the other side, even to that furnished by his own quotations from various authors, the progress of geological science might have been spared the hindrance of a theory, which is now, and has long been, its greatest obstacle. He quotes a passage from Strabo,

upon the mobility, pliability, or plasticity, of the main mass of the earth at great depths, where it is saturated with water, which might well have been written by your correspondent himself. But no other way having occurred to the lovers of this science to account for the elevation and depression of continents, except by earthquakes and volcanic action, it was determined that all doubtful phenomena must be accounted for that way; and that way they have been accounted for, even to the extreme absurdity of teaching that small streams of lava could be forced up in a fused state through the crevices of rocks filled with water, still retaining sufficient fluidity to flow over adjoining tracts of country, passing through beds of coal without firing them, and through limestone without discharging its carbonic acid, wound up by the final monstrosity of teaching that our crystallized mineral veins, containing various metals and earths, in every kind of chemical union and disunion, have been forced up in a fused state from some vast reservoir of molten metals in the earth below. This is no wild and exploded theory, as we might conceive, of the dark ages—it was actually taught by the late lamented Sir H. De la Beeche, and applied by him for the instruction and guidance of mining in Cornwall.

Now, how is it to be explained, that a science commenced with so much caution, with so prudential a reserve of venturing on premature theories, which I know of my personal knowledge to have been the habitual views of the founders of the science, should all of a sudden come to a dead stop in its progress, and its professors refuse resolutely to learn any more? This is the actual fact; the discoveries made in geology *proper*, during the past 15 or 20 years, in which the igneous delusion has been acquiring such a metallic consolidation, made in strict accordance with the facts of mineralogy, crystallography, and the vast accession to physical science accumulated by the labors of Faraday and others, are equal in value to all that had previously been done since the commencement of the science 50 years ago. But, in spite of the extraordinary progress of chemistry, and every branch of natural science, and the unthought of revelations of magnetism, the professors of geology shut out all light, and obstinately pin their faith and the minds of their pupils on the antique ideas of Leibnitz, framed at a date when our knowledge of the elements was confined to the four terms—earth, air, fire, water. I fear this assumed *finality* in the advance of so useful a science, the refusal to learn any more, is very much caused by the routine necessity which is inseparable from government offices. Since the completion of the Geological Survey of Great Britain, which is a map of the surface, the science has assumed a mere superficial character. Professors, established by authority to teach, are naturally supposed to know all their subject; they must not appear at a loss to their pupils; and thus

a study quite in its infancy, and which had always been so acknowledged, has been brought to rank with the definite rules of arithmetic, writing, and other old matters well established, which no one holds any doubt about. The science being closed, discussion is at an end; no new views, based upon the facts which lovers of truth collected, for the very purpose of leading minds to new and more perfect truths, can be listened to. They must not be heard, because they would disturb the routine of the seminary—immortal science is subjected to a military discipline; the orders of the general in command are paramount; according to his own views of office he decrees "Thus far shalt thou go and no farther." This may have been necessary for a time, but there is now such a flood of counter-truth accumulating that the routine, ere long, must be altered, the school-books reformed, and made consistent with the progress made in geology during the last 20 years. I may be said to have received its study by inheritance; and deeply interested in its progress, I look upon the admirable remarks of your correspondent as heralding the dawn of improvement. I hail them with the greatest gratification.

ART. V.—ON THE STUDY OF GEOLOGY AND MINERALOGY AS SOURCES OF INTERESTING AND VALUABLE INFORMATION. —By GEORGE HENWOOD, M. E.

IN none of the whole range of sciences is there a greater field for thought or study, than in the sister, or rather *twin* sciences before named.

Here may students refer to nature's own library, and study the arcana of the great FIRST CAUSE written by that finger whose works alone are imperishable.

> "Here may they tread the path HE trod,
> And mark the footsteps of a GOD!"

Nor need they fear satiety, or that the treasury of wonders, will ever be exhausted, for with Pope they may exclaim—

> "Come forth, O man, extend thy wond'ring eyes,
> Millions beyond the former millions rise!"

The vast profusion of subject, though it might well deter students, should not paralyze or overcome them, for like all the grand creations of the GREAT PROFOUND, the steps to their attainment are so gradual, that though they may never be able to penetrate all the hidden wonders, yet they may be competent to comprehend a great deal—perhaps they may never rival a Hutton, a Werner, or a Davy,—yet they may be enabled to make considerable progress in the paths of these sciences. In whatever part of the world they may chance to be located, they are sur-

rounded by material for study, and should they roam to distant lands, I can conceive of no more real enjoyment, than to take up a stone on the foreign shore—to call it by its name, tell its locality, and to say I know your family, relations, properties, and all about them, and am glad to find you here.

Is it not, think you, a source of gratification, that the very stones should be your companions? Especially if they, as they may have done before, should show you their valuable qualities, which the uninitiated would spurn or heedlessly cast aside?

Is not this, think you, a source of valuable information?

Yet all this is attainable by a little attention to these studies.

As an example among others, I may cite this small pebble I hold in my hand, which I picked up on the sea shore of the mounts bay. It displays in its formation a map or epitome of the phenomena observed in the distribution of the mineral veins in Cornwall and Devon, its limited space containing both north and south, east and west lodes, cross courses, contra lodes, dropper strings or feeders, as they are sometimes called; as well as junctions of the lodes, this circumstance occurring in metallic veins, usually creates a bunch of valuable mineral; it also shows a heave and the dip or underlie of the various lodes, and may be said truly to be a pocket edition of these phenomena.

Setting aside all secondary or mercenary views, allow me first to direct your attention to the subject of my proem or text, if you please, the *emollit mores*, and I think no more impressive or lasting lesson is taught, than by studying nature in some of her sublime creations in Geology.

In illustrating this subject, I shall detail my own experience, and the effect I observed on others, in visiting some remarkable Caverns in this country. I shall select three of a distinct series, and describe the circumstances and particulars of the visits, as nearly as memory and my notes will allow me. They comprise the Tresco Cavern, in an island so called, one of the Scilly group; Wookey Hole, near Cheddar, Wells, Somersetshire; and Clapham Cave, under the Ingleborough Mountain, Yorkshire. The Tresco Cavern lies on the north side of the island, and you land at the mouth of the cave on a beach of shingle, between huge granite rocks; the entrance is narrow, and after certain winds its examination is with difficulty effected, its exploration should only be attempted in a boat in very fine weather; being on the sea shore of an island on which are few, very few inhabitants, its approach is not without danger.

Being so remote it is seldom visited, it is therefore necessary the explorers should take with them candles, flambeaux, &c.; a small boat has to be dragged over the shingle to give this curious place a thorough investigation, as without this aid you cannot examine the lake.

After proceeding some forty or fifty yards through the narrow and low roofed passage, the roof and sides expand, and the visitor finds himself in a vast cavern; at his feet is a beach of fine granitic sand, and before him a placid subterranean lake of fresh water, presenting a curious and striking contrast to the ceaseless hubbub and strife on the billows of the Atlantic in immediate proximity, whose echo still rings in his ears.

The sides of this interesting spot are formed of blocks of granite, having nearly a vertical section in their divisions or clefts.

The roof is overlaid by immense masses of tabular or horizontal slabs of the same rock; a most interesting example of this perpendicular and horizontal arrangement of granites is to be seen at St. Michael's Mount, Cornwall; the granite is of a similar character, except that the vertical series in the latter are stanniferous (or tin bearing), and slightly cupiferous (copper bearing). At the time of my visit to the islands of Scilly, my object was mainly to ascertain if any vestiges of ancient tin works existed, similar to those found in various parts of Cornwall, as pretensions had been put forward that they were the Cassiterides (or islands of tin), mentioned by Strabo and other ancient authors.

After a careful survey of several of the islands, I concluded if ever they had that appellation it could not have been derived from their own produce, or if so, they had removed all vestiges of their works with their tin.

The placid lake of which I have before spoken, being fresh water, is a very curious phenomenon, indicating a prolific spring in some part of it, as there is always a percolation of fresh water into the sea.

I judged it to be slightly above the sea level; not having proper instruments I had no opportunity of ascertaining this particular correctly.

The lake is said to be unfathomable, but of this I have my doubts, as every part I tried it in, I found soundings with a fishing line and lead at a few fathoms; the lake appears to be about one hundred yards across, and on its further shore is a fine sandy beach. The roof can be but indistinctly defined, the candles provided not giving sufficient light to show the extreme height; it appeared in no part to exceed forty feet, indeed the island itself is not very high, and I should say forty or fifty feet is the utmost altitude, though local measurements give it almost as unlimited scope as they do the depth.

Here then is a subject for the speculative geologist, the tabular and vertical granite! The subterranean lake, with all its phenomena!! What a train of thought is here open to the student!

It has been conjectured the island is the apex of an ancient mountain, thrust up since the formation of the tabular granite, whose masses have been upheaved by the vertical, that the lake is the crater of an extinct volcano, that the resistance caused by

the superincumbent mass, obliged the liquid vitreous matter to force itself a passage through the place that now forms the entrance; (examples of this nature may be seen at Vesuvius, and other volcanoes now in active operation,) and that down the sides of the mountain ran the igneous flood, ages on ages before the limpid waters of the ocean approached their present position.

This is, of course, entirely speculative, and can never be propounded as literally correct.

Having been accompanied by boatmen only, whose frequent visits to the place had rendered them familiar, I had no opportunity of judging the effects on others, but for myself, I must say I was deeply impressed with the sense of the POWER which had created these marvels, and whilst gazing on the lake, was forcibly struck with the words, "The waters HE holdeth in the hollow of HIS hand." This cavern being wholly granite, afforded no stalagmites, stalactites, or basaltic columns so generally found in caves, but was still not less interesting and instructive.

The next cave to be considered, is situated in the Mendip hills, near the city of Wells, in the county of Somersetshire. This, like the preceding, is approached by a very narrow entrance for several yards, when the cavern expands to a considerable width and a prodigious altitude; it appears to have been one of those clefts, or ravines, so common in the mountain limestone formation. At the surface it appears the roof of this cleft is composed of conglomerate limestone; the pebbles, varying considerably in size and cemented by lime strongly impregnated with oxide of iron.

The depth of this ravine I could not ascertain, although I tried it with an iron ball and fifty fathoms of line, no bottom could be found. A path formed partly by nature and partly by art, has been extended through the cave, so that no danger need be apprehended, though for some distance it is quite close to the yawning abyss.

The cavern is continuous and passable by visitors for nearly half a mile, but by the aid of ropes and ladders it has been explored for a greater distance. It is said a fox, that had been set off at the extreme end approachable by visitors, had made his exit at a place three miles off in the Cheddar cliffs; this I think is highly probable; others assert its continuance to Banwell cave, a much greater distance, and very unlikely to be true.

About two-thirds of the way, is a beautiful stream of water of remarkable purity and clearness, which empties itself from its subterranean passage at some distance lower down the vale than the entrance to the cave; this river is of sufficient volume to drive the machinery of a paper mill erected on its banks, the water is peculiarly adapted to the manufacture of papers of a superior quality, the extreme purity of the water being highly desirable for this purpose. At the entrance is now placed a wicket gate,

and visitors for a trifling gratuity are accompanied by guides, who are well acquainted with the place, who provide candles and a small quantity of tow, which being steeped in turpentine or spirits of wine, is fastened by wire to the end of a long pole, elevated for the purpose of showing the roof, and some magnificent stalactites depending from above, or adhering to the sides of the cavern; a pistol is usually fired at the widest part of it, when the echo and reverberations are extraordinary, and produce surprising effects. In some parts are small pools of water, collected by the continual dropping of the roof; many of these being surcharged with carbonate of lime, have the quality of encasing in stone most substances placed therein. This is improperly called petrifying; but it only surrounds the articles with, and does not convert them into, stone. The variety of objects brought to undergo this process is as surprising as the number; birds' nests seem to be the favorite specimens; then true lover's knots, wax models of fruit and flowers, and I have even seen a counsellor's wig brought to be petrified, perhaps his heart needed it not.

The guides, here, as elsewhere, have specimens in abundance on sale (all, of course genuine Wookey produce), to supply the curious in such matters.

There are vast quantities of beautiful stalactites and stalagmites, some of which assume the most grotesque and fantastic forms, to which names have accordingly been assigned; thus there is one group called the Lady Rock, but from any resemblance, it might have been as properly called any thing else. There is the Bee-hive; this is certainly much more like the original, but the solitude reigning here ill accords with that usually busy scene.

Then there are the Kail Pots, containing some very fine stalagmites, nearly white; some of the stalactites, dependent from the roof, and adhering to the walls of the cavern, appear like huge flitches of bacon, and as may be supposed, are complimented by that appellation; many of these are translucent, and when the flambeaux are placed behind them, afford some curious effects.

The stalactites were formerly much more numerous than at present; that truly English notion of having a bit of every thing remarkable by way of memento, prevailed here to such an extent, that had it not been put a stop to, it is doubtful if a vestige would have been left. There may yet be seen traces of where magnificent stalactites once existed, that have been destroyed for very wantonness, or the silly gratification of seeing them topple down the sides, and into the gulf I have previously described.

Pity 'tis, 'tis true, but true it is, this reckless conduct is too often the case, and that too by parties who ought to know better; many a precious gem of nature's handy work has been destroyed merely to gratify the cupidity of the curiosity hunter, who places it in his collection (too often of worthless trash), and is for ever

lost to the world. I trust and believe a better feeling is now prevalent, and that we shall in future see less of this mutilation, especially if the "*study of the liberal sciences tends to improve men's manners.*" I visited this place in company with an esteemed friend, with whom I spent a few days in rambling over the Mendip hills on a geological excursion. The effect of these few days I may best show, by making an extract from a letter received from him a few months subsequently.

After adverting to some personal affairs, he says, "I have been very busy in arranging and numbering my Ammonites, Encrinites, and other fossils, and I assure you I begin to flatter myself on having a tolerable collection illustrative of our district. I shall never forget that delightful week in which a new world was opened to my view, or I should rather have said, an old world was resuscitated; and never, never, will the glories of Wookey be erased from my mind."

This youth afterwards became a clever geologist, is now in the East India Company's service, and has had ample opportunities of attending to his favorite science, with what results, we shall see in the sequel.

Thus you see, he was so struck by a single week's experience, that he never forgot it, and his is by no means a solitary instance.

Several smaller caves occur in the Mendip and Quantock Hills; also in Somersetshire.

Some years since, at Banwell, one was accidentally discovered, containing a huge deposit of animal bones, among which were those of the wolf, the bear, and the hyena, together with large quantities of bones of the smaller animals, many of them partially gnawed; proving these holes to have been the haunts of wild beasts.

From the number found, it would appear as if they had retreated to this stronghold in the presence of that flood, which at length overwhelmed them; the undisturbed state of the remains seems to prove they had remained untouched from the day of the catastrophe to the hour of their discovery.

The third example I referred to, is the Clapham Cave, under the Ingleborough Mountain, and here (as it quite illustrates my subject) you will perhaps allow me to digress a little, from a literal description of the Cave, and to include that of the visit.

It was upon one of those days in autumn, when nature is about to resume her winter garb, that being in the neighborhood, I observed a hand-bill announcing a cheap trip from Bradford to this interesting spot, which was on that day to be thrown open for public inspection through the liberality of the worthy proprietor, W. Farrer, Esq., to whose attention and care the whole country is indebted for the perfect and beautiful state of the various attractions in this celebrated cave; the work of clearing out and

drainage, after its discovery, was executed entirely under his personal superintendence; the judicious management of which difficult task, together with the slightly altered state of the place, by forming a pathway, presents a strong and favorable contrast to most works of this kind, and bespeaks a highly cultivated taste for the beautiful.

Like most similar spots, the discovery was accidental, and the opening small. By placing the ear near a rock in the valley in which the entrance is situated, the sound of a subterranean stream was, and still is, distinctly audible.

This stream, which descends from the hill, at a distance of a mile from the cavern, falls into a deep chasm perpendicularly. For a great depth the aperture is not large, but the noise is sometimes terrific; this waterfall is called the Jingle Pot.

Proper care has been taken not to allow the prevalent custom of carrying off mementos, and no one is allowed to enter except he be accompanied by a guide; a trifling charge is made to defray the expense of candles, attendance, &c.

At the time of my visit about one hundred persons, of all grades and both sexes, were waiting admission, who were allowed to explore it in companies of about twenty at a time; ample opportunity was allowed for examination, no party being limited to time.

The stalactites and stalagmites here are singularly beautiful; one piece of stalagmite, termed the font, is certainly very like the object after which it is called; but no effort of the Gothic artist ever conceived, or the hand of the carver ever executed such delicate tracery, or such magnificent corbels and pendants, as are to be seen here. The color of these formations are also very various, from the snow white, through all the gradations, to the rich peculiar brown of old oak. The stalactites vary in size from that of a reed to that of a man's body; these again are formed into groups, and assume most grotesque outlines; one group is certainly not a bad representation of an elephant, with its enormous trunk, and of course has been christened by that name.

Most of the more prominent groups have names that are quite unnecessary to be repeated here.

Some of the stalactites are hollow, and many of them are sonorous when struck by a hard substance.

In one spot there is a group called the Piano, and the opening in the cave where it is situated the drawing-room. In another part, where the cavern expands, and the roof is at a great height, there is a group called the organ, and certainly in this instance most appropriately; the stalactites forming no bad representation to the pipes of that instrument.

On approaching this spot, the company with whom I entered (from the continued expressions of surprise and admiration tha

burst forth at every step, I presumed had never been in a similar situation before), were asked by the guide if any among them could sing, for if so, said he, I can accompany you on nature's own music. He then struck out a merry popular air, to the manifest wonder of all.

The various notes are produced by striking the stalagmites at different heights from the base, and they emit a very agreeable and musical sound. Practice has taught the guide his art,—it is truly surprising how dexterously he exercises it.

Whether it arose from diffidence, or an overwhelming consciousness of their situation, being then one mile from the entrance, and more than a quarter of a mile from the perpendicular surface, or whether their attention was too much engrossed, I know not, but all were mute. After several minutes' silence, I suggested that as we were then in the midst of, and had that day been admiring and contemplating some of HIS stupendous works, we could not do better, or render a more appropriate homage, than, being accompanied by an instrument of His own wonderful formation, carol forth from that abyss HIS praise, which would doubtless ascend as gratefully as if offered from the choir of a cathedral. I then gave out the Doxology, in which all joined heartily, and from the depths of that cavern, "Praise God from whom all blessings flow," was warbled forth, with as much true devotion, as it ever was uttered by the same lips, and I hesitate not to say, every individual in that assembly, received an impression he has not yet forgotten, and left that scene an improved member of society, and a better man.

Such scenes as these, lead not to superstition or infidelity, but tend to elevate the thought, improve the taste, cultivate the understanding, and are particularly deserving the attention of youth.

This cavern has also its subterranean stream running for about a mile underground; this has been proved by placing sawdust in the water at its entrance into the earth at the Jingle Pot, and its egress from the hill side, below the entrance into the cave, charged with that substance. This cavern is far better worth visiting than either of the others before mentioned; the visitors will join with me in hearty thanks to the worthy proprietor for the manner in which he exercises his curatorship, and his extreme liberality in allowing its inspection at all reasonable times, to persons who ask permission, and leave their addresses.

The proof that these studies are of immense pecuniary value, I think is much more easily shown, than their worth as sources of mental improvement.

To the miner, the architect, the agriculturist, the chemist,—in short to almost every man it is of vital importance. To the miner its thorough knowledge is a *sine qua non*, without which he may, as he has before done in his ignorance, throw away prodigious sums in searching for minerals in localities in which nature

was never yet known to place them. The want of this knowl has brought many families to ruin, by parties persevering in ous speculations that the man of science would have inst condemned, and have given his reasons for condemnation.

How many thousands on thousands of pounds would been saved, that have been squandered in the vain hope of curing coal in situations in which it is impossible they could e and how many thousands on thousands have been gaine operations in spots not even suspected by the vulgar to co that valuable mineral. The practical and scientific man, ta analogy and experience for his guides, heeds not contempt ridicule, but works fearlessly on, expending his capital in full fidence, and at length meets with his well and justly earned rew

In the Mendip hills I have seen the remains of most e sive works pushed on with vigor and confidence for many y in the hope in due time of finding the seam; to this were encouraged and incited by the productiveness of a n boring colliery, and although the viewer of that work wa them of their error, and pointed out the conditions under w it was impossible they could succeed, yet despite this salt warning, on they went, week after week and month after m until all their capital was exhausted, and ruin overtook t when they ascribed their severe loss not to the true cause (v want of knowledge), but to the ruinous chances of mining.

On the other hand, a young friend of mine, called John C tian, a native of a village near Truro, Cornwall, who had care attended to these matters, not as a profession, but as a farmer in that capacity emigrated to Australia (this was before golden diggings had been ascertained), and located on a sp at once saw from the formation of the superstrata contained beneath, although not an ounce was to be found at the su Having selected an extensive range in the neighborhood navigable river, he, with his own small capital and a little he able to borrow, purchased the whole section, sunk a pit, and f he was not deceived, for he discovered a valuable and exte coal field. He sold a moiety of his underground rights, for a that would startle the most fortunate gold digger. He still re one-half of the produce of the coal field, and the whole of the face property in his possession. The value of his land for b ing purposes and wharfage has so increased, and will so inc by the commerce that will necessarily be attracted to this an dean NEWCASTLE (the place is so called), that I think he ma fairly said to have met his reward, and fully prove my posi

The young gentleman I before alluded to as having go India in the Government service, found his knowledge of importance to him also; an expedition being set on foot fo interior, it was deemed highly desirable a geologist should ac pany the party. He was selected, gained his promotion in

sequence, and now fills an honorable post in that country that may fairly be said to have originated in his attention to these sciences, as without patronage, even in that country the road to preferment in government employment is but tardy. Lately the wonderful discoveries in California had almost shaken the speculative world from its propriety (if it ever had any by the way), when Hargreave, one of the California adventurers from Australia, who had landed in that golden region, was so struck with its analogy to the country he had recently left, that he instantly proclaimed Australia would some day rival California in her metallic produce. He immediately proceeded to his own country, where the local government had offered a reward to the first person who should prove the fact of gold being in sufficient quantities to pay for working. Hargreave at once claimed the prize, proved his position, and gained the reward, paltry though it was comparatively speaking.*

John Calvert, too, led by analogy and experience, discovered the precious metal in situations never before suspected. He now heralds its presence in our own island, and is daily giving proof to the sceptic that knowledge is power and wealth. I might multiply similar proofs till their repetition became tiresome.

To the architect and builder the attainment of these sciences is of paramount importance; the beauty and durability of their structures depend in a great measure on their geological knowledge, and even the workman who lays the stone, should, in many instances, know how the stone laid in its native bed, as much of its enduring qualities depend on its being laid in the same position. To the chemist a rich field of operation is indeed laid open—here may he revel in all the glories of his science—here he has nature's own laboratory, and labors for his school and instruction—here may he dissect, re-arrange, combine, her wonderful productions; and here too has he the opportunity of proving in a pecuniary point of view the value of his studies in mineralogy. How many instances of this nature may be cited? A volume might be written on the subject!

To the agriculturist, its necessity is obvious; on his knowledge of the various soils and their power of production, depends his very existence, yet the application of geological science to agriculture until lately has been sadly neglected; our farmers now begin to make this one of the first consideration, as without it the most expensive manures and careful management may be expended in vain; with it the soil apparently barren and worthless may be reclaimed and rendered capable of cultivation.

* If genius were to wait for the patronage of governments, I fear it would have to wait for ever. The memory of the great is too often idolized when the great are gone, but the consciousness of having effected works for the benefit of mankind cannot be filched, and must continue to be the reward of the industrious student, though the rich and powerful may neglect and the ignorant and careless deride.

To the most casual observer I am sure it must be interestin and I think I have proved it to be edifying, and profitable; no allow me to show how knowledge so valuable, may be easil obtained, particularly by the young.

I would have in every town, in some easily accessible plac such as the Mechanics' Institution, or Museum, if there be one, in large public schools, Geological and Mineralogical Pillars, invented by that eminent scholar and persevering geologist, D Paris, of Penzance, which consists merely of a pole having a spir shelf, on which are placed carefully selected specimens illustrati of the different strata, from granite to the highest in the serie each division colored in consonance, with a map showing the i clinations, basins, &c. On the edge of this shelf is placed a rin on which should be painted in large characters the name of t stratum, and in small characters the metals found in the stratu

In the corresponding series in the mineralogical pillar, I woul have good specimens of the different metals and minerals place numbered, and a book of reference to the localities whence pr cured; this would simplify the study, and every student woul be able to refer to his own locality for investigation; this I ho would create an interest, and that once excited, I have no fear f the future.

In the present state of society, I deem it as essentially necess ry, these sciences should form part and parcel of a youth's educ tion, as drawing, music, astronomy, or any other of the accomplis ments that tend to the general welfare.

I think I have shown, the amounts at stake on the thorou attainment of these sciences, are as great as on most branches our national industry. What would England become witho her mines of coal, copper, tin, iron, and the like! The prop working of these depends entirely on my premises; I would al at periodical intervals, have the advantage of some plain, practic lectures on these subjects; most of the lectures, and most of t works written on these matters, are too full of scientific terms, ar tend more to show off the attainments of the lecturer, than to i terest and improve the younger part of his auditory. I have objection to the most scientific lectures imaginable, but let the be confined to more advanced circles; I would also, where prac cable, have classes formed, and visit localities where there a geological phenomena denuded, such as faults, junctions, heave slides, lodes, veins, and the like; and there a little impromp instruction may be given with effect.

I would, where these advantages are not obtainable, ha good examples procured and explained in a familar manner; think it cannot be too familiar for good results. I have know many a youth disheartened by the tremendous catalogue of ha names that meets his eye on entering a museum, and lookin

over a series of specimens. He thinks he must have a brain like a dictionary, to retain one-half the incomprehensible terms, and that he must be a proficient in all languages to understand and pronounce them; but this is purely ideal, they gradually unravel themselves, and the pupil feels surprised how easily this apparent difficulty resolves itself; true it is, a knowledge of languages greatly assists, but is not absolutely indispensable.

The necessity of such a branch of education in this country is, I believe, universally admitted, and we are lamentably behind Germany and other states on the Continent in this respect, though as working miners immeasurably their superiors.

The cost and trouble of the experiment are but trifling, the reward how great! It wants but the will, the way is obvious.

It had struck that celebrated chemist and philosopher, Andrew Crosse, of Taunton, that the decomposition and crystallization of metals and rocks might be effected by electricity and galvanism. After many patient trials, he at length succeeded in producing minute crystals of copper on this cylinder; this experiment led him to try to deposit the crystals on foreign bodies, with what result these splendid groups of native and ruby copper abundantly testify; the crystals are of the most perfect form, and are deposited on a mere bit of porous earthenware.

He has likewise by the same method produced on porous ware the curious varieties of moss copper and malachite, partaking of all the characteristics of these varieties of the metal found in natural deposits.

This piece of white marble bears the impress of a sovereign nearly as perfect as if it had been taken in wax. This curious experiment was effected by a galvanic battery, the coin being merely covered by pieces of platina and zinc foils, the poles were applied, decomposition of the marble rapidly took place wherever it came in contact with the gold. May not this simple experiment some day be made available for the useful arts?

Again, few of the sciences afford greater bodily recreation; scrambling over the hills and dales is capital exercise for youth, and in such rambles the student often comes upon landscapes and views that are seldom seen by the road traveller or tourist. He would therefore do well to know something of drawing, as that would enable him to depict the forms of the mountains and hills; these generally by their outlines bespeak their geological structure. How truly are sciences and arts a sisterhood! how invariably they serve as handmaidens to each other!

The requisites to commence these studies even on a large scale are so few and inexpensive, that they are within the reach of all, and merely consist of a sketch and memorandum book, a pocket compass and dip rule to take the bearings and underlie of the strata, a miner's pick of small size, a few iron wedges or chisels,

and a basket to carry home the produce of the day's exploration. I have found a good-sized fishing pannier the most convenient for carriage. To these necessaries must be added for home use a volume of Phillips' Mineralogy, some charcoal, a blow-pipe, lamp, a few fluxes, and the student is furnished with necessaries that will last him for some time.

I hope I have shown the study of these objects is of importance to youth as sources of valuable instruction—that they are interesting I think all will admit—that they tend greatly to improve the taste and cultivate the mind I hope has been sufficiently proved, and that those who tread the path will have no reason to wish to retrace their steps I am sure.

From the wonderful revelations made of the existence of a series of extinct ages and races, of which no history but the book of nature is left; these studies have been erroneously supposed to lead to infidelity, and to be antagonistic to the history revealed to us in the holy volume; this only occurs to shallow minds, and those who have only taken a mere superficial view of them. To such I would say, PERSEVERE, and you will find all in harmony, and that the study of His works reveal the truth of His written WORD, AND LEADS FROM NATURE'S WORKS UP TO NATURE'S GOD.

ART. VI.—COPPER REGION OF TENNESSEE. A SKETCH OF THE GEOLOGY OF TENNESSEE. By RICHARD O. CURREY, M. D., Knoxville, Tenn.

CONSIDERING the very recent date since the first discovery of copper ore in Tennessee, the rapid developments following thereupon afford another striking instance of the readiness with which capitalists will enter upon such explorations when once convinced of their importance and value.

Copper District.—The range of mountains along the eastern boundary of Tennessee is composed of the metamorphic series of rocks. They possess a N. E. and S. W. course, the strata dipping at various angles, from 45° to 90° to the S. E. It is in this range of mountains that the Copper district of Tennessee is situated. Pursuing this same general direction beyond the limits of Tennessee, the discoveries of Copper have been made in Carrol and Floyd counties, Virginia, and doubtless it is the same mineral band which extends on to Maryland and Pennsylvania. Southwestward the band may be traced through the interior counties of Georgia even to the State of Alabama. There is a striking resemblance in the rock strata throughout this entire mineral region. In the Unaka mountains, between Tennessee and North

Carolina, the band is found to pursue a tortuous course, only here and there presenting itself on the Tennessee declivity.

In North Carolina the metamorphic rocks underlie the older primary strata, while in Tennessee they overlie the more recent silurian or fossiliferous rocks. These metamorphic strata consist of micaceous slates, quartzose sandstones, chlorite slates and primary limestones, interstratified with beds of porphyry, chertzy limestones and conglomerates.

It is in these metamorphic slates, especially between the micaceous slates and quartzose sandstones, that the veins of Copper have been found. They are indicated by the outcrops of *gossan*, which is a porous oxide of Iron, tarnished, to a greater or less degree, with thin films of some ore of Copper—most generally the carbonate.

History of the Discovery, and the Progress of the Mining of Copper at Ducktown.—Having thus pointed out in a few words the general outlines of this great mineral zone, we shall enter upon a particular account of the early mining operations, and the success attending them in this new and productive field.

In the south-eastern corner of Tennessee, a region sparsely inhabited, and, on account of its ruggedness and inacessibility, scarcely ever visited, the discovery of Copper was made.

During the gold-hunting excitement of a few years ago, which was vigorously prosecuted in Northern Georgia, Western N. Carolina, and the mountain districts of East Tennessee, almost every rill and branch were traced to their very source, and every alluvial deposit on their banks was washed and panned in search of this precious metal. These explorations were vigorously prosecuted from 1830 to 1836, and during this period every part of the present Copper region was carefully examined, not only by the practical operator with his pan, but the Legislature of the State directed its Geologist, Dr. Troost, to visit this district and report thereupon at its next session. The result of these labors is embraced in his TENTH Report. The labors of that survey were mainly directed to the solution of the question of the value of the *gold* deposits, and consequently the only end attained was "that gold is not so abundant in the Ocoee District as is generally supposed;" but of this we shall give an account when we enter upon the consideration of gold.

Passing through the country near Ducktown, Dr. Troost noticed at several places masses of *hydroxide of iron*—which he pronounced of good quality, and possessing value, "especially in this country, which is not susceptible of cultivation, and where there is an inexhaustible abundance of wood." The sequel of this description will show that this was the out-cropping of the valuable deposits of Copper at the same locality.

Attention being thus directed to this point by the foregoing report, the foundation of Zion iron works was laid in 1849 by Mr.

Duggar, and enterprising iron master from Johnson county. He erected a small furnace for making iron on the banks of Potato creek, where the ore was abundantly found. This is the site of the present Cherokee Copper mines. The very high price of iron all through the mountains was such as to warrant a paying investment to Mr. Duggar.

The ordinary price was from eight to nine cents per lb. In March of 1847, Mr. Duggar purchased eighty acres in section 21, being a portion of the land at present belonging to the Cherokee mine, for $20 and 200 lbs. of Iron, which latter payment was to be made when the contemplated forge should be in operation. A dam was thrown across Potato creek, and the work of the forge reached through the whole season, so that it was not until April of 1848 that Iron was produced from this establishment. At first the ore promised much. It looked well, and welded in the loop very readily. It would draw well until it cooled to a cherry red, then it would break across and in pieces. If heated to a white color, and immersed in water, until cold, it would show a very thin Copper precipitate on the surface. Sometimes the forge frame had a greenish tinge. After many trials to make a good merchantable Iron from the ore, the proprietor of this establishment began to examine the Iron out-croppings in the vicinity with the hope that a better ore could be found. Trials were made with no better success from ore up Potato creek, and from the same range in Georgia. At length ore was found about fourteen miles across the strata to the south-east in Georgia, capable of working into a fair quality of Iron. This ore was hauled to the furnace at a cost of $5 per ton—the cost of coal being 23 cents per bushel. This forge continued in operation about two years, making in that time nearly five hundred tons of Iron, which supplied a large country, and considerable of it found markets at Dahlonega, Elijay, and the neighboring towns.

A single forge and tilt-hammer, with a water-blast made up this establishment, which, with the dam across Potato creek, cost about $700.

We go back a few years in our sketch to note another peculiarity in the development of this mineral region.

In August of 1843, a Mr. Lemmons, who had been operating on this creek, was induced, by some singular appearance in the earth, to make some attempt to find the precious metal on a small branch on section nine, which falls into Potato creek. This is now the location of the Hiwassee Copper Mine. A small opening was made, and the washings were very successful. In a reddish brown and blackish decomposed rock, the supposed gold was found in large crystals of a deep rich red color. The fortunate discoverer toiled without rest the whole day long to secure the enormous treasure fortune was offering him. At a late twilight hour the precious metal was gathered up and packed; the sleeves

of the discoverer's coat was filled, and secured at the cuffs by a hickory-bark withe. This greater fortune was so unexpected that nothing larger than a goose quill was at hand in which to store the gold, so that the coat was taken. Mr. Lemmons, slinging his treasure across his shoulder, moved homeward, leaving his pan concealed in the bushes ready for another day's labor. On reaching his rude cabin, whiskey was sent for to help in the rejoicings, and mirth and joy resounded over those low mountain tops long after midnight, so that another sun found not a ready laborer. The next day the gold was again examined, and lo! its color was changed from the bright red, which was thought a sign of great richness, to a dark, dingy brown. This brought fears, and night stole the fortune of the day.—The gold proved to be red oxide of Copper in crystals. This event produced some excitement; but soon passed away, and no one knew the nature and extent of the metal thus discovered, or even its value. Some further work was done by Mr. Grant, who found several rich specimens of native Copper. This section of country, and the workings so far as were opened, was examined by a Geologist of this State, who gave a very unfavorable report of the district. Soon after this examination, the property changed owners, and the company, who purchased, explored the ground a little farther by cutting a trench up the branch, where Lemmons had found his gold. This work exposed to view the black oxide of Copper, which was not known to the persons whose enterprise had thus led them to embark in mining. Several tons of ore were broken and thrown out of the trench. A box of samples, including specimens of the rocks in the neighborhood, was made up and sent to Nicholas Haight, New York, for examination. This box, however, contained but a small fragment of ore, which was thought by the parties who opened this trench to be nothing but a dark brown and blackish valueless stone. The report upon these samples was that a single dark fragment produced 11 per cent. of Copper, and that the great mass of specimens were made up mainly of Iron.

This unexpected report discouraged the present operators. Their ardor was checked, and all mining operations suspended when a report of the "samples" became known. The season passed away, and in the last of April, 1847, a German, by the name of A. J. Weaver, from the District of Werner, saw the trench, and informed the parties interested that the black rocks, as they were here called, were rich Copper ore. Mr. Weaver began the first mining under a lease, paying one fifteenth of the gross products of the mine. This arrangement was really the beginning of mining in this locality. On the first of May, 1847, work was resumed in the old trench, and ninety casks were shipped to the Revere Smelting Works, at Port Shively, near Boston. This ore was made up in two lots. No. 1 was worth 32½ per

point so calm, so smoth, that in the quietness of its festooned island, may be imagined a home for water nymphs. Thus alternately, the road passes by the calm and the boisterous of this picturesque stream. Although for twenty miles it is making its meandering way underneath its northern bank, yet an air line from Clouds to the mines, is probably not more than half the distance; but it is only such a line as the strong-winged eagle can pursue.

At the time of my visit, I made a geological section of this route which I will briefly describe — extending it beyond the mines through Angelico Gap, to Murphy, North Carolina.

Beginning at Ducktown, for one and a-half miles as we go westward, we pass over alternate layers of mica slate, quartz and sandstone. At Brush creek, three miles, a blue slate is succeeded by sandstone thoroughly impregnated with particles of arsenical iron, similar to the rock taken from the Western Tunnel at Ducktown. The thickness of this rock is very great, sometimes constituting of itself heavy layers, and at others, presenting the appearance of veins penetrating a grayish white sandstone. We do not lose sight of it till we have reached, in the windings of the road, seven and a-half miles from Ducktown. To this slate succeeds. At nine miles, there was found a mass of gossan, which was succeeded by sandstone. To this came a blue slate, succeeded by an immense stratum of a porphyritic rock filled with rounded quartz pebbles. The base was evidently softer than the pebbles, presenting where exposed for any length of time to the weather, a porous character, the cementing substance being washed out, and leaving the pebbles adhering by a slight contact. At the 12 mile post, was a slate; at 13, a sandstone, and at fifteen a chlorite slate with cubes of iron pyrites, such as I had seen at Coqua creek in the Gold region. It here presented high overhanging cliffs. At 17 miles we had the same stratum of porphyry with quartz pebbles, and at eighteen and a-half miles was a blue slate twisted and contorted into knots of all conceivable shapes and sizes, interstratified with irregular veins of a reddish colored mineral.

At Clouds, 20 miles, a shaft had been sunk and a tunnel opened, through a grayish micaceous sandstone, and at Guerins', seven miles south of the river, another shaft had been sunk through greenish chlorite slate.

Beginning at Ducktown again, and going eastward into North Carolina, we notice at Congdon's the *gossan* underlaid by a reddish sandstone, over which lies the mica slate, of a whitish and reddish white color. This is also the basis of the Hiwassee and Isabella mines, as well as others in this vicinity. Between these mines and Angelico Gap, the boundary lines of the States of Tennessee and North Carolina, the character of the rock strata

and the general surface of the country, consisting of rounded dome-like hills and ridges, are altogether similar. No remarkable outcrop of gossan was found east of Isabella mine, but frequently the sandstone assumed a highly ferruginous character.

Reaching the summit of Unaka mountains, at Angelico Gap, another rich repast was spread before me. At my feet, but a few miles distant, lay the rich mining region of Ducktown, the whole country thronged to overflowing with ardent speculators, while farther to the West rose the towering peak of Frog mountain. To the East, the mountain heights and wide-spread valleys of the old North State, presented such a scene as I had never before beheld. My thoughts involuntarily turned to the struggles of the revolutionary sires who battled hard against foes without and tories within, and as I gazed thus alternately upon the birthplace of my ancestors, and my own loved Tennessee, I felt the strength of the tie which he feels who dearly prizes the home of his birth.

Beyond the Unaka mountains the strata possess some similarity to those in Tennessee, the only difference being in the purer metamorphic character which they acquire. At Murphy, a stratum of primitive limestone, of a snow-white color, was examined, which has been noticed elsewhere.

The discoveries at Ducktown led to an examination of this whole region. Many failed in their haste to be made rich, others *hit* upon lucky spots—and localities yet remain undeveloped, teeming with treasure to the fortunate adventurer.

(To be continued.)

ART. VII.—THE MINING OF COAL, &c., &c. By A. T. PONSON. No.

[Continued from page 470, Vol. VII.]

CHAP. II.—THE MEANS BY WHICH TO PENETRATE THE EARTH.

PITS AND GALLERIES IN GENERAL.

107. *Definitions.*

EVERY cylindrical or prismatic excavation, of which the transverse section is very small, compared with its length, whether dug in the bosom of a deposit or in barren rocks, is a *pit* or a *gallery*, according as its axis approaches a vertical or horizontal position.

Pits or galleries are dug into seams, or into the enclosing rocks. The first properly belong to the chapter devoted to the working, strictly speaking; the second class designed to pene-

trate the heart of a deposit is the only one requiring present attention.

Some parts of a pit receive particular names, to wit, the *orifice*, or the upper extremity which opens to "the day," also in the mine the outlet of the *interior* pits; the *bottom* or lower extremity; the lateral faces or *walls*. The various excavations receive names drawn from the uses to which they are applied; thus we distinguish the *ascending* and *descending*, and *ventilating* shafts, &c.

In galleries we also have the outlet "to day," the *extremity* or point where it terminates, the four surfaces, *walls*, &c.

Galleries which are dug in the enclosing rocks and cut the strata perpendicular to the line of their direction, are *transverse galleries;* they pursue the shortest course to a deposit, and pierce it in as nearly a straight line as possible, but if the strata change, their direction should be modified.

108. *Pits and Galleries dug in the Enclosing Rocks.*

If the coal series simply covered by vegetable soil contains straight beds easy to be exposed, if cut by deep valleys, it shows the layers of coal, stratified in veins approaching a horizontal direction, and their profiles on the sides of hills, principally in steep parts. We can, by proceeding from the outcrop, dig vertically or horizontally a great distance without encountering the dead rock; but the excavation made in the deposit must follow all its sinuosities, and this circumstance, which offers but little inconvenience to galleries, provided their bottom can be maintained in a horizontal direction, is, on the contrary, very disadvantageous when we dig in right (direct) strata, for the pits being subject to the inflexions of the seam, are consequently inclined and often broken; their walls are with difficulty sustained; the linings (supports) must be constantly renewed, and the cables being so long are quickly used up, by reason of the friction to which they are exposed. Thus the excavations chiefly used on the left bank of the Meuse, at Breuzot, and at many other places at a period when mining was in its infancy, are now entirely proscribed, and vertical pits dug in the sterile rock, are exclusively used.

109. *Pits and Galleries dug in the Deposit.*

In a level country, the only means for reaching the seams, whatever may be their inclination, consists in digging a pit. The axis of the pit should always be strictly vertical, for although a normal line to a stratification may be the shortest, and though, consequently, seams generally inclined, seem to demand pits equally inclined, yet every deviation from a vertical line induces consequences the most serious, with regard to the solidity and the use of the excavation.

When the surface of the ground is uneven, it is convenient to

open onthe sides of the hills some galleries, of which it is necessary to direct the axis in a manner sensibly horizontal.* Indeed, if they are inclined, they must either ascend or descend from the side of the hill or mountain. If they ascend, all the cuttings of seams situated between a horizontal plane passing through their orifice, and another plane coinciding with their bottom or base, will be lost for working; if they descend, the transportation of the coal will be more laborious and costly, and the natural flow of the water will be prevented.

110. *Forms assigned to Excavations.*

The modifications which pits have, are relative to the form of their section by a plane perpendicular to their axis. Thus we have the square, rectangular, polygonal, circular, elliptical, &c. These forms, which possess advantages and disadvantages, depend on local uses, and the nature of the lining of the walls. In a series, the stratifications of which are nearly horizontal, the pressure being every where the same, a circular section is convenient, since, then, every point of the circumference offers equal resistance. If the pits are to be lined with walling (masonry), or if they traverse a series disposed to cave in large masses, the circle likewise is the form which offers the greatest solidity. But if a circular pit is desired to be used for various purposes (and this is usually the case when they are designed to serve for the extraction of the coal), the drawing off of water, and the passage for the miners by ladders, they are at an equal section, smaller than rectangular or square pits. In short, the loss of space is always less in the latter than the former, where, by the use of compartments, there are always angles which it is impossible to avoid, or make good use of. Pits lined with wood require a rectangular form, and it is necessary to be careful to oppose the smaller sides to the inclination of the series, the part which exerts the greatest pressure; that is to say, we should place the small sides parallel with the direction of the strata. The Germans use alike, both rectangular and square pits, with a lining of masonry.

The sections of galleries do not offer forms so various or regular as those of pits; they are, in case of being walled, rectangular, combined with one or two circular or elliptical sections; when lined with wood they are rectangular, trapezoidal, and sometimes quadrilateral. These excavations are never modified with regard to their form, but from the purposes for which they are to be used. Thus we say galleries for *extraction*, *drainage*, *ventilation*, &c.

111. *Dimensions of Pits and Galleries.*

The dimensions of the transverse section of pits are very va-

* Galleries are never entirely horizontal, but are always inclined some degrees to one side where the water can flow.

riable. They depend principally upon the nature of the series to be traversed and the uses to which they are to be applied. Thus the size of the vessels for transportation determine that of those for extraction; the kind and number of the pumps that of those for drainage.

In Belgium the diameter of the circular sections varies from 1.80 to 2 and 3 metres. In the north of England the limits are comprised between 3 and 5 metres, and sometimes reach 6.50.

The Germans give to theirs large dimensions, whatever may be the form of their section. The district of the Ruht contains many of 5 and 6 metres.

Square pits, which are the smallest, are 1.80 metres on each side, but they are rarely made; the rectangular are preferred. The breadth of these is 1.30 to 2.25 metres, and their length from 3 to 5 metres. In the province of Liege, the length is sometimes 5.50 metres.

The same causes produce similar variations in the dimensions of the sections of galleries. When they are designed exclusively for the drainage of water, their breadth is 1.20 to 1.50 metres with a height about the same. The galleries for extraction have a section proportionate to the activity of the transportation. They have a single or double way, that is to say, two trains of vehicles can be run through simultaneously; the extreme limits are—breadth, 1.25 to 3 metres; height, 1.50 to 1.80 and 2 metres.

It cannot be said that the cost of a gallery is proportionally less as its section is smaller; for, when we attain the minimum limit, the workman, confined in his movements, labors with difficulty. Very different considerations guide the miner in determining the dimensions of the excavations of this kind adopted at deposits.

112. *On Pits designed for Various Uses.*

From the fact that pits take their name from the use to which they are applied, it should not be inferred that pits are destined for a single object only. On the contrary, they are so arranged that they serve at the same time for two, three, and even four different uses. A pit for extraction will allow the air to penetrate, which ventilates the works below, whilst another pit used for extraction, or for the descent of the workmen by ladders serves as an outlet for the air. On a large surface we unite pits of extraction and drainage, and the two serve also for the descent of air. Sometimes the pit for the ladder is also added. Often when a single pit is divided into three or four compartments it serves for as many distinct uses.

(To be Continued.)

Art. VIII.—ALUMINIUM—THE PROGRESS IN ITS MANUFACTURE.

By W. J. Taylor.*

The use of sodium in the reduction of metals from their chlorides, as has been so successfully accomplished within the last two years, may be justly considered a great progressive step in science.

Aluminium has been the first in which this process has been perfected. What the other metals are which will be reduced successfully from their chlorides by the use of sodium, the future will determine. Some facts concerning the early history of aluminium, the progress made in its manufacture, and the numerous uses to which it can be applied, will not be uninteresting.

Much confusion existed in the minds of the early alchymists regarding the oxide alumina. They knew of an alum which was brought from the East, which they regarded for a long time as sulphuric acid combined with an earth. Stahl and others also mistook this earth for lime. Geoffroy, in 1728, pointed out its existence in clay; Marggraff, in 1754, proved it to be a substance having a separate existence and peculiar characters. To Oerstedt belongs the credit of first preparing the chloride of aluminium, from which compound Wöhler, in 1827, succeeded in first eliminating the metal. Wöhler first obtained aluminium in the form a gray powder, by heating gradually in a porcelain crucible over a spirit lamp equal volumes of metallic potassium and chloride of aluminium; other chemists, by slight modifications of this process, have obtained aluminium in the form of the gray powder, as first obtained by Wöhler.

To M. Sainte Claire Deville belongs the credit for first improving the process, so as to produce aluminium in such quantities that its character as a metal could be fully investigated. M. Ste. Claire Deville used in his process sodium as a substitute for potassium. (It requires 39 parts of potassium to produce the same reductive effect as 23 parts of sodium.) At the time of his first experiments sodium was worth one hundred dollars per pound; he so improved the process for making this metal as to reduce the price to ninety cents per pound.

At this time the chloride of aluminium was regarded with sodium as a curiosity of the laboratory; it was then produced in small quantities by heating alumina mixed with coal, in a porcelain tube, and passing over it a current of dry chlorine gas.

M. Ste. Claire Deville made farther improvements in this process, so as to make it in an apparatus as large as a gas retort and in

* From the proceedings of the Academy of Natural Sciences, January, 1857.

quantities proportional, at a price of twenty-five cents per pound. To produce the reaction of sodium with the chloride of aluminium was the most difficult point of the entire process. M. Ste. Claire Deville used for the reduction the distillation of the chloride of aluminium over the sodium, which was placed in trays of copper enclosed in a tube. The temperature developed by the reaction is very great if the current of the chloride of aluminium be rapid; by this process it was found that it required at least ten pounds of sodium to produce one pound of aluminium (part of the aluminium produced being destroyed at its formation by the scoriæ), when by theory it required only two and a half pounds. This great loss of sodium and the difficulties in conducting this reaction on a large scale, were very great objections to the process.

All the aluminium at the Paris Exhibition was made by this process, and it was from a portion of this that M. Regnault made his investigations, and in which he found copper and iron. The copper came from the trays in which the reduction was made. The presence of these metals in small quantities will account for the peculiar physical properties which he ascribed to aluminium.

Circumstances having interrupted M. Ste. Claire Deville in the experiments which he was making on a large scale, the subject rested for a while here. In the meanwhile Heinrich Rose suggested and made experiments with cryolite (a fluoride of aluminium and sodium), and gave his views that this mineral was a valuable substance from which to produce aluminium.

Wöhler made experiments also with cryolite, and arrived at conclusions somewhat similar to Heinrich Rose. They both succeeded in producing some of the metal, but the results were not entirely satisfactory.

M. Ste. Claire Deville again resumed his experiments, but instead of distilling the chloride of aluminium on the metallic sodium, as in his first experiments, he fused in a crucible, in the manner pursued by Rose and Wöhler, using, however, with the double chloride of aluminium and sodium, and the metallic sodium, the fluoride of calcium (fluor spar), or some cryolite as a flux. This experiment of M. Deville was very satisfactory, and the reduction in accordance with the theory.

While these experiments were in progress in Europe, similar ones were being made in this country by Mr. Alfred Monnier, in Camden, N. J.; to him credit is due for having first made aluminium in the United States. Having had opportunities for examining his processes for making the double chloride of aluminium and sodium, metallic sodium, and the modes of reduction, melting and refining the aluminium, the conclusion is satisfactory that the discoveries of science have been successfully applied to render the manufacture of this metal an industrial art.

Mr. Monnier in his experiments met with the same difficulties

in the reduction. He found, however, by careful investigation and analysis, that the effect produced was also perfectly in accordance with the theory. When, after great difficulties, sufficient quantities of pure aluminium were obtained, and its properties as a metal carefully studied; it was found that it was not in the least degree oxidized by fusion with the nitrate of potash. This peculiar property causes a strong contrast between it and any well-known metal, and this wonderful fact produced a new phase in the manufacture of aluminium. Owing to this discovery, the efforts which had been made to produce aluminium from perfectly pure material were found unnecessary.

By using pure materials for its manufacture, it was necessary to employ apparatus which was very costly, as it required that it should be free from any injurious substances.

By the facility with which aluminium can be refined, owing to its peculiar properties to resist oxidation, it can be manufactured from impure and crude materials, in apparatus which can be cheaply made of still cheaper material, and without the great care and watchfulness necessary in the manipulations, where pure materials are employed.

Since July, 1855, Mr. Monnier has made the double chloride by mixing alumina with salt (chloride of sodium) and coal, and by passing over this mass (ignited) a current of dry chlorine gas (kaolin or common clay can be used instead of the alumina). The double chloride runs out from the condenser in a stream, and is collected in a receiver; it becomes solid when cold.

The reaction is so complete that no chlorine is lost. It has already been manufactured at a cost of eight cents per pound, but the operations were carried on to a very limited extent. It is, however, clearly (to be) demonstrated that, with works of sufficient size and a proportional economy in manufacture, the double chloride of aluminium and sodium, can be produced at a cost not exceeding four and a half cents per pound.

In the manufacture of sodium Mr. Monnier has made considerable improvement; it has already been produced at a cost of twenty-five cents per pound.

In the manufacture of zinc (by the Belgian process) one retort produces about thirteen pounds of metal in 24 hours. In the manufacture of sodium the reduction is so quick that 52 pounds of this metal can be produced in a retort of the same size in the same space of time.

The reduction of zinc costs from two to two and a quarter cents per pound. The amount of ore necessary, being from a half to three-quarter cents per pound. Giving for the cost of one pound of metal about three to three and a quarter cents.

The reduction of sodium costs about . .	4	cents per pound.
The carbonate of soda, 2½ lbs. at 4 cents, .	10	" "
Giving for total cost of one pound of sodium, .	14	"

Sodium can be manufactured on as large a scale as zinc, and when the workmen have the same practical experience in the manipulations, the price of reduction will be still farther reduced, so that the difference between it and zinc will be that of the first cost of carbonate of soda and the zinc ore.

It has already been shown that the double chloride of aluminium and sodium can be produced at a very low price; metallic sodium can also be made very cheaply; the reduction is readily effected in accordance with the theory, but the difficulty in uniting the metallic globules of aluminium when formed, is obviated by stirring at this point with a rod, and the destruction of the metal by the alkaline scoria is prevented by adding to the charge of the double chloride of aluminium and sodium and metallic sodium, either fluoride of calcium (fluor spar), or cryolite.

By these means the greater portion of the metal is united in one mass, the other portion of the metal in small globules remains with the slag, which can be removed mechanically, or by first digesting in water; there will however remain about ten per cent. with the slag. This will be explained by the following data. Theoretically:

	250	parts of metallic Sodium produce
	100	" " Aluminium;
	70	parts are obtained in one metallic mass;
	20	" " in metallic globules;
	90	" being the net produce.
	10	" remain with the scoria.
Total,	100	

The alkaline scoria contains large quantities of the chloride of sodium, that can be easily extracted by water, leaving an insoluble residue from which the fluoride of aluminium can be extracted by volatilization. The scoria containing the fluoride and the metallic aluminium is economically used by introducing it again with a new charge of the double chloride of aluminium and sodium, and metallic sodium, and by that means the loss of the metal is rendered very small.

Aluminium, when carefully removed from any slag, is readily fused in a crucible by itself; when in fusion (which is at a lower point than that required to fuse silver) the whole is stirred with a rod, and all the globules of metal are united in one mass with the greatest facility; at this point nitrate of potash can be added (the stirring continued).

All other metals are oxidized by this process; the refining is finished when the metal has a pure white color. It can now be poured into a mould of any shape.

(To be continued.)

JOURNAL OF MINING LAWS AND REGULATIONS.

JOHN WILSON HAWKSWORTH and others, agt. HEMAN J. REDFIELD. } United States Circuit Court.—Jan. 27, 1857. Before Hon. Judge INGERSOLL.

This was an action to obtain the return of duties paid under protest on a quantity of steel imported from England. The plaintiffs claim that under the tariff of 1846 the articles were only dutiable at 15 per cent *ad valorem*, whilst the Custom House authorities charged 20 per cent. Mr. McKeon, United States District Attorney, appeared for the government, and Messrs. Ridgway and McCullough for the plaintiffs. This is one of many suits which involve several hundred thousand dollars.

Judge Ingersoll, in charging the Jury said—

Gentlemen of the Jury—It will not require many remarks from me to enable you correctly to determine the question which is submitted to your consideration. By the tariff act of 1846 there is a duty imposed upon all steel of 20 per cent. excepting from that, steel in bars, cast, shear or German. The importations under consideration made by the plaintiff in this case, were of steel. The duty imposed on that importation by the collector, and which duty was paid, was 20 per cent.; and as the article upon which that duty was imposed was steel, it follows that the imposition was correct, unless the steel thus imported was either cast, shear or German. As it is admitted that it was neither cast, or shear, it follows that the imposition was correct, unless it is made to appear that it was German. It appears very clear that the evidence given in court, and about which there can be no mistake, that there is a steel manufactured in Germany which has been manufactured there for a great many years, and which is known among the commercial community in this country as German steel. That steel so manufactured and so known, is made from the ore direct, and it has this peculiarity about it, that the steel so made in Germany, according to the understanding of the witnesses, is the only steel made directly from the ore, that it is made from an ore found in Germany, and that there are no similar ores in the world, except one found in Hungary, and one found in the United States, which two latter have not been worked for the manufacture of steel; so that this peculiar steel is only made in Germany, to wit; made from the ore, is known as German steel, and must have been known to the makers of the act of Congress in 1846 as German steel, and intended by them to be included in the term "German steel." The theory which they set up on the part of the plaintiff is this:—That although this is German steel and within the meaning of the provision of the act of Congress referred to, yet it is not the only German steel comprehended in this act; that there is a kind of steel manufactured in Sheffield, England, well known among the commercial community as "German steel," although not manufactured in Germany, and not from any ore that came from Germany, but from iron ore in England. The plaintiff says that it is well known in Sheffield, and claims to prove that it is well known in this country: that there are four kinds known in England, to wit:—the blister seel, the first process from the ore; the German steel (in controversy) which they say is a process from the blister; the cast and shear, which are further processes from what they call the German; and that the steel made by this first process from the blister is known as German steel; that it is equally well known in this country as German steel, and was so known at the time this act of Congress was passed in 1846, as the other kind of steel made in Germany. If they are successful in establishing and in satisfying you that this kind of steel, thus made from the blister, in England, was generally known among the commercial community in the trade of this country, and among men engaged in that trade, as German steel, it must be presumed to have been contemplated by the makers

of this act of Congress to be included in this exception. I say that if, in 1846, when this act of Congress was passed, this was according to the commercial understanding of the term used in our market, in the markets of the United States; if it is so generally understood to be "German steel," it must be within the exception of this act of Congress, although it was not made in Germany. And the only question here for you to determine is one of fact: was this article now in controversy, at the time this act of Congress was passed, in 1846, so generally known in the commercial community of this country as German steel? If it was your verdict must be in favor of the plaintiff. You apprehend what is meant by the "understanding of the commercial community" in this country. It is, was it generally understood by them? Not that it was understood by a few—one or more—but was it generally understood, so that if an order was given for "German steel" that order would be answered by a response to it of steel manufactured in Sheffield, under the first process from blister, no matter what form it assumed? The question then is one of fact. Was it so generally understood? If it is so generally understood, that has nothing to do with the question—was it so generally understood in 1846?—for parties in interest cannot give a different construction to the law of Congress, passed in 1846, by changing the definition of terms. We look to the definition of the term as it was understood in 1846; and if at this period this article is generally understood in the mercantile community of the United States, or of any other country as German steel, but was not so understood in 1846, it cannot come within the exception; for the act excepts that which at the time, and at that time only, was generally known among the commercial community to be German steel. I will not allude particularly to the several witnesses that have been introduced. There have been many introduced on the part of the plaintiff who are, most of them, I believe, agents for foreign manufactories—many of whom were not residing in this country at the time this act was passed. They tell you that in England this was known as German steel, sent here as German steel, and coach-spring steel, but known there as German steel by the manufacturing and commercial community; while on the part of the defence other gentlemen are introduced to you, engaged in the manufacture of steel and other branches of manufacture, who tell you that they never heard of this article being called German steel until subsequent to the passage of this act, that to that time they never heard of it under that name. Therefore it is claimed on the part of the defence, that this article cannot be known generally to the commercial community as German steel; and, as I before said, it must be known generally to the community as German steel, and not by a particular portion of it. If men situated as these are, knowing what are the terms given to steel—if they never heard of it being known as German steel, it could hardly be generally so known. It has been claimed on the part of the defence that the only name given to this, and by which it was known for a time, was spring steel. It is proper for you to look at the case in that point of view; for if it was known as spring steel, and known by no other term, then it could not be known as German steel. But it does not follow that if known as spring steel, it might not be known also as German steel; and therefore I charge you in pursuance of the claim of the plaintiff, that if at the time this act of Congress was passed, it was generally known in the community as German steel, it would not deprive the plaintiff of the benefit of the exception in the act of Congress, provided it was equally well known as spring steel. If it was not generally known as German steel at the time this act of Congress was passed, then the plaintiff cannot take advantage of the exception in this act. If you should think, from the evidence, it was generally known to the commercial community of this country as German steel, you will give a verdict in favor of the plaintiff; otherwise you will find in favor of the defendant. The law is that it must be not only in foreign, but in domestic trade—it must be known in both. I said to you in the latter part of my charge, that if it was known in this country as German steel, it would

not deprive the plaintiff of the benefit of the exception of this act of Congress provided it was equally well known as spring steel. I mean, that if it is known in this country as spring steel, and is well known in the commercial community generally as German steel also, it must be known in this country.

Verdict for the defendant.

COMMERCIAL ASPECT OF THE MINING INTEREST.

MINING STOCKS IN BOSTON.

BOSTON, Feb. 1, 1857.

The market for mining Stocks has been well sustained since our last, especially for the better class of shares, and the continued advance in the price of ingot copper adds materially to the intrinsic value, of those Companies which are getting out copper to considerable extent. The New Year opens well for mining enterprises and the prospects ahead are more flattering than ever for continued success.

Minnesota has improved from 103 to 110, which is now bid without producing sellers. It is understood that the net profits of the mine for 1856 will be full $18 per share, and consequently a dividend of $15 per share is quite certain to be declared at the annual meeting in March next. This Company had a considerable amount (some 300 tons) of copper on hand at the first commencement of the rise in price which will add materially to the profits. A mass of pure silver weighing *sixty-five* pounds and worth $1000 has recently been taken out of this mine, but although of importance in itself, it is very doubtful if the profits of the concern are ever materially augmented from this source. Silver has been met with several times before, though not, we believe, in any one lump so large as the above, but it is not probable that a *vein* of it will be discovered, and otherwise the amount is not likely to prove large. The product of the Minnesota for November was 156½ tons, making for 11 months 1708 tons against 1308, for the corresponding period of 1855. The new machinery for this mine reached Ontonagon, Dec. 9, but was previously reported as detained on the way. This machinery is of importance to the successful working of the mine and will enable the operations of 1857 to be carried on to much better advantage than heretofore. The smelting returns for 1856 show 72½ per cent. an improvement of 1½ per cent. on the previous, which is an important gain.

Pittsburg has improved from 240 dividends (accidentally quoted 140 in our last), to 245 dividend off, equal to a gain of $20 per share. The dividend, now payable, is for 6 months and $15 per share on 6000 shares, making a total of $135 per share paid to stockholders ($810,000) since the commencement dividends in May, 1849, during which time no semi-annual payment has been missed. In the table of prices for the year 1856, in our last, the dividend of Company in August of that year was erroneously stated. It should have $20 instead of 0 as printed. The product of the Pittsburg for Novem-

ber was 126 tons, making 1648 tons for the year to December 1, against 1861 for the corresponding period in 1855. There seems to be little doubt that the

BOSTON MINING SHARE LIST.

Fluctuations for January, 1857, in fifteen different Copper Mining Stocks, sold at the Boston Brokers Board, showing their highest and lowest points, and the date, with the Market Value at the close of the Month, Gain or Loss for the Month and number of shares sold in each.

MINING STOCKS, BOSTON	Location of Office	Nominal Capital	Nominal Par.	Number of Shares	Paid in per Share	Total paid in	Highest Sales.	Day of month.	Lowest Sales.	Day of month.	Value Jan. 31	From Dec. 31 Gain.	From Dec. 31 Loss.	Shares sold in Jan. 57.	Shares sold in Dec.
Copper Falls	Boston	$500,000	25	20,000	$20,00	$400,000	5½	16	5 ‡	8	5½	2	—	85	711
Central	Pittsburg, Pa.	500,000	25	20,000	0,85	17,000	—	—	—	—	5	0	0	no sale	no sale
Flint Steel River	New York	500,000	25	20,000	2,50	50,000	—	—	—	—	3¼	—	1	no sale	35
Huron	Boston	500,000	25	20,000	4,50	90,000	—	—	—	—	2½	0	0	no sale	no sale
Isle Royale	Boston	——	—	12,000	14,00	168,000	8½	9	6½	16	8	1½	—	1391	1448
Minesota	New York	1,000,000	50	20,000	3,20	66,000	110	31	102½	5	110	9	—	67	90
National	Pittsburg, Pa.	250,000	25	* 10,000	11,00	110,000	—	—	—	—	45	13	—	no sale	10
North American	Pittsburg, Pa.	300,000	30	† 10,000	23,50	211,500	—	—	—	—	25	0	0	no sale	no sale
Norwich	New York	500,000	25	20,000	10,00	200,000	—	—	—	—	2½	0	0	no sale	no sale
Pewabic	Boston	500,000	25	20,000	1,75	35,000	6	7	5½	27	5½	—	½	558	1654
Pittsburg (Cliff)	Pittsburg, Pa.	——	—	6,000	18,50	110,905	255	26	255	26	240 †	18	—	1	59
Phœnix	Boston	300,000	30	10,000	9,00	90,000	—	—	—	—	2	0	0	no sale	50
Quincy	Detroit, Mich.	——	—	8,000	6,50	52,000	—	—	—	—	8½	0	0	no sale	no sale
Rockland	New York	500,000	25	20,000	2,00	40,000	36½	10	36½	10	40	5	—	20	55
Superior	New York	500,000	25	20,000	1,00	20,000	8½	16	8½	16	8½	—	½	200	692

* 1000 shares of the North American are not assessable. † Pittsburg Copper Company ex-dividend of $15 per share, on 6000 shares, for 6 months earnings. ‡ Copper Falls assessment paid $2 per share December 22, 1856.

mine will continue to pay at least $15 every 6 months on its present capital of 6000 shares, equal to $9 on 20,000 shares. There has been some talk of its

creasing the number of shares to 20,000, same as the Minnesota, which would give 3½ new shares for each of the old ones, and make the market price 73½ per share, taking $245, the present value, as a basis.

Rockland has advanced from 35 to 40, which is now the asking price for several lots. The advance has been rapid from about 30, and some parties are disposed to realize a profit. It is generally conceded that this mine will be a "Second Minnesota," in due time, and is rapidly approaching that desirable point. The product for November was only 23½ tons, no effort being made to get out copper, and this is not a fair criterion of the ability of the mine. The average per month for 1857, will probably reach 40 to 50 tons.

National has also advanced steadily from 33 to 45, with more buyers than sellers at the latter price. Recent advices from the mine are very encouraging, and there is the best of evidence that it will prove a very profitable one. *North American* has sold in small lots at 24, which is now the bidding price and none on the market. It is highly probable that the three mines above named, *Rockland*, *National* and *North American*, will take their place in the dividend paying list after the present year.

Isle Royale has fluctuated from 6½ to 8¼ and is now declining again, 7 being about the price. Recent accounts from the mine are said to be highly favorable and that the future prospects never were better. Pewabic has fallen off again and would not now bring more than 4½, a decline of $1¼ per share. The success of this mine for 1856 was very great, the product being 110 tons for its first year. Recent advices however have rendered it probable that the amount of copper raised this winter will not be so large as has been anticipated, owing to the hardness of the rock and a greater devotion of time and means to the work of opening the mine. There is little doubt though that the product of 1857 will largely exceed that of 1856. There is *a fear* with shareholders, both in this mine and the *Isle Royale*, that an assessment may be necessary in the spring for carrying on the mines successfully, and this tends to keep down the price of the stock.

Copper Falls run up rapidly from about $3 to 6, but is now dull again at 5 asked and 3 bid without sales. There is nothing new from the mine that we are aware of. *Central* has declined to $4, but the shares are in demand at the reduced price. *Superior* has receded to 8½, now the asking price, and Flint Steel River to $3. Each of these stocks will probably be assessed $1 per share shortly, for the purpose of prosecuting mining operations with vigor. The present amount paid in on the Flint Steel is $2,50 per share and $1 on Superior. The latter, however, was laid for the purchase of new territory and not for working the mine.

Norwich has been offered at 2½ recently and does not find buyers even at that figure. We hear nothing from this mine recently, and judging from the market price should not be surprised if a farther assessment was soon forthcoming.

Phœnix is quoted 1¼ to 2 and will doubtless soon be assessed 50 cents, or $1 per share.

Toltec sells at 1½, just a commission over the recent assessment. *Winthrop* is wanted at 25 cents, and is offered for 50 cents per share without transactions.

LAKE SUPERIOR MINING.

In a previous article some months since, we stated that the product of the various Lake Superior Mines for 1856 would reach full 5,000 tons. Although the amount raised has not been ascertained to a certainty the following table will give it very nearly accurate. The figures do not show the increase of product for 1856 over 1855, only the increase in the amount shipped. But, as there is always more or less copper left over, at the close of navigation, this is not of material consequence, except that the Lake was open last year longer than usual, thus affording greater facilities for shipping all the Copper on hand ready for market.

The following tables are digests, with slight corrections, from more elaborate ones prepared for the *Lake Superior Miner*, by Mr. Brunschweiler, of Ontonagon, and by Capt. Paull of the North American Mine, and from official statements.

SHIPMENTS OF ROUGH COPPER, IN TONS, FOR 1856.

From Ontonagon.	Mass.	Brl. and Stamp.	Total
Adventure	27	118	145
Aztec	15	40½	55½
Douglas Houghton	½	8½	9
Evergreen	4½	15	19½
Flint Steel River		2	2
Forest	1	49	50
J. R. Grout		2	2
Mass	10	3	13
Merchant		½	½
Minnesot	1861	497	1858
National	55	60	115
Nebraska	11	22	33
Norwich	71	45	116
Ohio		½	½
Ohio Trap Rock		4½	4½
Peninsula		½	½
Ridge	4	58	62
Rockland	91½	108	199½
Toltec	11	49	60
Windsor	6	16	22
Total...	1668	1099	2767

From Keweenaw Point.	Mass.	Brl. and Stamp.
Central		58
Cliff (Pittsburg and Boston)		1548
Connecticut		22
Copper Falls		154
Fulton		2
North American		332
North Western		15
Phœnix		11
Total		2128
From Portage Lake.		
Isle Royale		228
Huron		22
Pewabic		96
Portage		101
Quincy		20
Total		462

Total Shipments.	1856	1855
From Ontonagon	2767	198
From Keweenaw Point	2128	224
From Portage Lake	462	31
	5357	454

COPPER RAISED FROM THE MINNESOTA, CLIFF, AND ROCKLAND MINES IN 185 .

	Minesot.	Cliff.	Rock-land.
January	159	120	
February	158	127	
March	165	145	26
April	159	150	
May	153	141	16
June	159	140	20
July	153	134	30
August	155	154	38
September	150	148	41
October	154	146	38
November	156	124	23
December	150	120	24
Total	1859 ts.	1647 ts.	245 t.

The above product of all the mines for 1856 (5,357 tons), reduced to ingot copper (that is, after being smelted), gives at 70 per cent. 3750 tons, which is worth over $2,000,000 at 27 cents. per lb., 2,000 lbs. to the ton.

COALS AND COLLIERIES.

STATISTICS OF THE ANTHRACITE TRADE.

The following extensive and complete statistics of the Anthracite Coal Trade for 1856 have been prepared by the editor of the "Miner's Journal" of Pottsville, the acknowledged organ of the Eastern Coal Trade; therefore are official, and can be relied upon.

The increase of Anthracite coal in 1856 is only 262,597 tons, against 654,223 tons in 1855, and the increase of all kinds embraced in the table is only 302,968 tons, against 652,492 tons increase in 1855 over the previous year;—

	1855. Tons.	1856. Tons.	Increase. Tons.	Decrease. Tons.
Schuylkill Region,				
By Railroad,	2,213,292	2,088,903		124,389
By Canal,	1,105,263	1,169,453	64,190	
Pinegrove,	*48,858	†85,499	26,641	
	3,367,413	3,333,855	90,831	124,389
Lehigh Region.				
Canal,	1,275,050	1,186,230		88,821
Railroad,	9,063	165,740	156,677	
Wyoming Region.				
Pennsylvania Coal Co.,	504,803	612,500	107,697	
Delaware and Hudson Co.,	565,460	499,650		65,810
N. Branch Canal,	464,039	510,631	46,592	
L. and Western Railroad Co.,	187,000	*305,530	118,530	
Shamokin Region,	116,117	137,406	21,289	
	6,488,945	6,751,542	541,617	279,020
		6,488,945	279,020	
Increase of Anthracite in 1856,		262,597	262,597	

Semi-Anthracite and Bituminous Coal Trade.

	Tons.	Tons.	Tons.	Tons.
Semi-Anthracite,				
Lykens Valley Co.,	66,721	61,187		5,534
Short Mt. Co.,	50,500	41,739		8,761
Dauphin,	1,000			1,000
Treverton,		73,112	73,112	
Broad Top,		42,000	42,000	
	118,221	218,038	115,112	15,295
Bituminous.				
Cumberland Region,	664,304	719,211	54,907	
Foreign Coal,	287,408	173,055		114,353
	1,069,933	1,110,304	170,019	129,648
		1,069,933	129,648	
Increase in 1856,		40,371	40,371	
Do. Anthracite,		262,597		
Total increase of all kinds in 1856,		302,968 tons.		

It is evident from the small increase in the supply of 1856 over 1855, that the markets will be bare of coal in the spring of 1857, and the increase required this year will, in all probability, be in the neighborhood of 800,000 tons, which can be furnished from the old and new regions in 1857, provided the transporting Companies procure the necessary rolling stock to carry it to market. The ability to mine coal is equal to the demand, provided it can be carried to market.

*The quantity sent from Pinegrove in 1855, was 80,701 tons, and in 1856, 111,148 tons. The balance is included in the shipment by Philadelphia and Reading Railroad Report, it having been received from the Dauphin and Susquehanna Railroad East.

†Of the 305,530 tons sent to market by the Delaware, Lackawanna and Great Western Railroad, 177,241 tons were sent South towards New York.

	Tons.
Total supply of Anthracite in 1856,	6,751,542
Furnished from Schuylkill County,	3,333,855
Other regions,	3,417,687
	3,333,855
Less than half the supply in 1856,	83,832

The principal increase is from the Wyoming Region, which amounts to 207,010 tons.

LIST OF COAL OPERATORS

In Schuylkill County, together with the quantity of coal sent to market by each in the year 1856:—

	Coll.		Tons.
R. Heckscher & Co.	4	209,097	286,765
E. Borda	2	67,386	
D. Glover	1	40,281	
Bast, Audenried & Co.	2	91,454	162,327
Bast & Pearson	1	70,573	
Brown & White	1	91,454	
D. P. Brown & Co.	2	43,288	159,824
J. C. White	1	25,088	
Wm. Milnes, Jr. & Co.	1	116,973	146,590
James Neill & Co.	1	29,607	
Kirk & Baum	3		137,223
Chas. Miller & Co.	4	84,707	119,205
Adams & Miller	1	37,498	
Geo. S. Reppller	1	57,038	129,271
do. Ashland	1	72,233	
Seven Firms	26		1,141,175
George W. Snyder	2		97,321
Rodgers, Sinnickson & Co.	4		88,249
J. & R. Carter	3		86,556
Jones & Cole	2		79,701
Wm. Johns	1		79,522
Rich. Kear	2		78,575
Wm. Donaldson	2		76,823
Wm. Y. Agard	3		71,406
John Tucker	2		69,554
Robt. Radcliff & Co.	1		64,746
Heaton & Carter	1		60,119
Conner & Patterson	1		59,041
Jno. Bancroft & Co.	1		59,031
E. H. F. Horton	1		58,950
Clark & Co.	2		57,593
22	52		2,326,992
John S. Graham	1		46,942
Wm. De Haven	4		43,660
Thos. Schollenberger,	2		42,113
F. J. Parvin	2		40,499
Geo. H. Potts	2		42,622
George Spencer	3		40,416
Jno. Dougherty	4		40,229
James M. Beatty & Co.	1		38,482
H. C. Harper	2		37,619
Jos. F. Taylor	1	21,467	35,251
Taylor & Co.	1	13,788	
Dolbin & Rodgers	2		34,076
Geo. Wiggan & Son	1		31,356
Peter Bowman	1		30,984
A. Sillyman	1		30,558
37	81		2,561,701
Wheeler & Miller	1		29,055
Samuel Sillyman	1		28,373
Steel & Patterson	1		28,641
L. P. Brooke & Co.	1		26,614
Wm. Levan	1		24,240
E. Hammer & Co.	1		24,185
B. Tyson	1		22,277
James Burey & Co.	2		20,819
H. Guitterman	1		20,706
John G. Hewes	1		20,187
47	92		2,806,788
McFarland & Verner	1		19,250
George Mason	1		16,568
Holman & Co.	1		15,544
L. S. Spangler	2		14,480
Wallace & Rothermel	1		14,457
Jno. C. Neville	2		14,421
J. B. Rorer	1		13,758
T. Jenkins & Co.	1		13,000
Kitzmiller & Stees	1		12,006
S. Chadwick	1		11,643
T. H. Winterstien	1		10,962
J. Wasley	1		9,788
J. Thomas	1		9,199
J. J. Williams	1		9,496
Lewis Diehl	1		8,197
Daniel Edwards	1		8,195
Chas. M. Hill, Agt.	1		8,178
Correll & Uhler	1		8,070
G. G. Schollenberger	1		7,584
J. J. Osterman & Co.	1		7,935
M. Bright	1		7,512
R. Jones	1		7,066
Wm. Price	1		6,618
J. Beacham	1		6,218
T. Garretson & Co.	1		6,187
Morgan Brace	1		5,567
Bacon, Price & Co.	1		5,296
Fisher & Co.	1		5,206
R. Gould	1		5,217
Thos. Wren & Co.	1		5,218
Molly & Newcommer	1		4,171
A. Miller	1		4,218
Wm. Littlehales	1		3,978
Little Sch. Coal Co.	1		3,510
G. Barnhart	1		2,968
W. W. Hall	1		2,614
J. F. Vorhies & Co.	1		2,808
Thos. Cassaday	1		2,806
Jno. McGinnis	1		2,270
L. C. Dougherty	1		2,767
F. Smeltz & Co.	1		2,065
W. & C. Brittain	1		1,917
Jenkins & Williams	1		1,796
W. Parmley	1		1,668
Adams & Powell	1		1,421
J. Ebert	1		469
Sundry shippers			4,878
94 Operators,		140 Collieries.	

The number of operators is annually diminishing in Schuylkill county, and the business is concentrating into a smaller number of hands.

Of the whole quantity shipped in 1856, from Schuylkill county, 3,333,855 tons, 47 of the 94 operators, mined and shipped 2,806,788 tons, leaving but 527,067 tons for the remaining 47 operators.

ANTHRACITE COAL TRADE IN 1857.

Shipments by Reading R. R. to Feb. 7th,	225,184	tons.
Same time last year,	186,496	"
Increase	48,688	"

LEHIGH COAL TRADE FOR 1857, BY RAILROAD.

Spring Mountain Mines,	9,768 08	tons.
East Sugar Loaf "	7,105 03	"
N. Y. & Lehigh "	3,792 12	"
Council Ridge "	4,567 13	"
Coleraine & Stafford "	4,201 17	"
German Penna. "	1,100 14	"
Dolbin & Dehaven "	233 13	"
Hazleton "	48 16	"
Total,	30,818 16	"

LEHIGH COAL TRADE FOR 1856, BY CANAL.

The coal sent from the Lehigh Region in 1856, was sent by the following companies and individual firms.

	1856.	
Summit Mines,	284,711 11	tons.
Room Run Mines,	64,291 10	"
East Lehigh Mines,	33,140 16	"
A. Lathrop's Pea Coal,	1,315 09	"
Spring Mountain Mines,	98,665 01	"
East Sugar Loaf Mines,	67,160 15	"
Colerain,	77,173 03	"
Stafford,	12,206 07	"
N. Y. & Lehigh Coal Co.	41,354 04	"
German Pennsylvania Coal Co.,	22,470 09	"
South Spring Mountain Ridge,	28,848 03	"
Hazleton Coal Co.,	135,288 05	"
Cranberry Mines,	74,746 06	"
Diamond Mines,	46,938 02	"
Council Ridge,	52,522 05	"
Buck Mountain Coal Co.,	101,127 18	"
Wilkesbarre Coal Co.,	20,964 10	"
Wyoming Coal,	12,778 16	"
Hartford Coal Co.,	10,526 08	"
Total,	1,186,229 18	"

Lehigh Valley Railroad.

Wm. Milnes & Co.,	86,617	tons.
Ratcliff & Johnson's,	2,180	"
Packer, Carter & Co.,	41,217	"
N. Y. & Lehigh,	13,336	"
Sharpe, Lebenring & Co.,	10,191	"
German Penna. Coal Co.,	8,640	"
Dolbin & Dehaven,	351	
Hazleton,	108	"
Total,	165,740	"
By Canal,	1,186,230	"
	1,351,970	"
Sent in 1855,	1,284,113	"
Increase in 1856,	67,857	"

The ability of this region is equal to an increased supply of about 100 to 150,000 tons. The increased supply will depend on the demand to a great extent.

MARYLAND COAL TRADE FOR 1857.

Shipments to January 31st..... 31,681 tons.

For the week ending Saturday, January 31, the Cumberland Coal and Iron Company's Railroad brought down 976.15 tons of coal, and the Cumberland and Pennsylvania Railroad 815 tons making a total from the Frostburg region, for the week, of 1,791.15 tons, and for the year, 11,368.14 tons.

During the same period there was shipped over the George's Creek Coal and Iron Company's Railroad, 3,357.09 tons, and the Hampshire Coal and Iron Company's Railroad, 1,154 tons, making a total for theweek, from the George's Creek region, of 4,511.09 tons, and for the year, 20,313.02 tons.

LEHIGH VALLEY RAILROAD.

The Coal se nt by Lehigh Valley Railroad in 1856 was disposed of as follows:

To Furnaces on Lehigh	72,185
Retail trade on Lehigh	6,121
North Penna. Railroad	187
Central Railroad	31,693
Belvidere and Delaware Railroad	54,719
To Morris' Canal	896
Total for the year, tons,	165,740

Our correspondent says:—We expect to increase very materially our rolling stock next year, and also build considerable of double track.—The North Pennsylvania Railroad has made a connection with us, and will no doubt take considerable Coal to Philadelphia to supply the retail trade.

EXPORTATION OF DOMESTIC COAL.

The exportation of domestic Coal is rapidly on the increase. In 1848 the whole quantity was only 9,309 tons, and in eight years it has increased to 136,596 tons, valued at $677,420. The large bulk goes to Canada and other British North American possessions:

	Tons.	*Value.*
1848	9,309	$41,142
1849	9,661	40,396
1850	33,741	167,080
1851	37,727	163,977
1852	45,336	188,906
1853	79,510	396,008
1854	93,884	443,506
1855	110,586	537,006
1856	136,594	677,420

Importation of Foreign Coal for the year ending Jan. 30, 1856, 173,055 tons, valued at $604,187.

The Coal exported for the year ending June 30, 1856, was sent as follows:

	Tons.
Danish West Indies	705
Gibraltar	317
Canada	81,624
Other British N. A. Possessions	5,410
British West Indies	20
British Australia	213
British East Indies	120
France on the Mediterranean	25
French West Indies	494
Spain on the Atlantic	563
Cuba	10,332
Two Sicilies	220
Hayti	302
Mexico	5,878
Central Republic	8,564
New Granada	16,168
Venezuela	893
Brazil	1,322
Uruguay	301
Buenos Ayres	33
Chili	115
Sandwich Islands	308
China	2,747
Whale Fisheries	40
Porto Rico	5
Total tons	136,594

The value of the exports is greater than the value of the imports, although the tonnage is less.

THE BOSTON COAL TRADE FOR 1856.

The imports of foreign Coal the past years have been as follows:

	Tons.	*Chaldrons.*
In 1856	6,085	38,838
1855	9,123	51,987
1854	12,685	43,438
1853	5,137	48,144
1852	9,818	40,754
1851	7,978	30,178
1850	6,246	32,081
1849	12,800	35,133
1848	5,952	41,079
1847	4,256	50,653

The receipts of domestic Coal since 1846 have been:

	Tons.	*Bushels.*
In 1856	411,174	
1855	389,108	
1854	374,217	
1853	363,113	4,539
1852	432,061	14,000
1851	356,758	88,290
1850	288,419	63,415
1849	262,632	20,809
1848	274,902	48,795
1847	258,093	158,795

COAL TRADE OF BALTIMORE.

Receipts of Coal at Baltimore for the past twelve years, to the 31st of December.

	Cumberland.	*Anthracite.*
	Tons.	*Tons.*
1845	16,000	90,000
1846	18,393	100,000
1847	50,259	110,000
1848	60,280	125,000
1849	71,679	140,000
1850	146,645	160,000
1851	163,855	200,000
1852	256,000	125,000
1853	406,000	183,000
1854	472,258	238,740
1855	394,442	263,747
1856	446,981	266,661

The Baltimore *Prices Current* states that throughout the whole year the demand for Cumberland Coal was greater than the supply.

COAL VALLEY MINING COMPANY.

The following paper was furnished us by N. B. Buford, Esq., the President of the Coal Valley Mining Company, who is also President of the Rock Island and Peoria Railroad:

This Company owns nearly 1,000 acres of the best coal lands in the State, situate eleven and a half miles south-east of the city of Rock Island, on the line of the Rock Island and Peoria Railroad, to which place it will be finished and in operation by the first day of April next.

The depot of the road is located about the centre of the coal basin. The track of the road is about seven feet below the principal vein of coal, which is from four to five and a half feet in thickness. This vein has been opened in twelve places, on both sides of the railroad, in the valley, at points one mile apart, and will yield on the company's property 3,500,000 tons of coal. It is worked by entries driven in the hills, under the superincumbent mass of slate, limestone, shale, ironstone, earth, &c., about 100 feet in height.

The mouths of the openings are connected together by semicircular railroads, which lead to the depot, at an elevation which allows the coal to be dumped into the cars of the Rock Island and Peoria Railroad, by which it can be delivered in the city of Rock Island, along the whole front of the city, next the Mississippi river, and dumped into the barges for delivering at any point on its banks.

This road also connects with the Chicago and Rock Island Road in a straight line, and thus, with the bridge across the Mississippi, the city of Davenport, the Mississippi and the Missouri Railroad, the Warsaw and Rockford Road, and to every other point of railroad communication with the city of Rock Island.

The great Coal field of the State of Illinois is bounded on the north by a line from Rock Island, via La Salle, to the Southern bend of lake Michigan, and is in contact with the Mississippi only at Rock Island.

There are several other coal basins in Rock Island, and Henry, the adjoining county on the east, three of which are successfully worked, and by connections with the Chicago and Rock Island Road, are supplying Chicago, Rock Island and Davenport, and are yielding to their owners profitable returns; but there are none of them of so great magnitude, or enjoying equal facilities for supplying the great demand on the Mississippi river, which reaches from Muscatine, 30 miles below Rock Island, to St. Paul, in Minnesota, a distance of 600 miles above—or for the support of the great manufacturing establishments that are rising in Rock Island, which will soon make this the second city in the State.

Since the construction of railroads to this place, the price of wood has advanced from two to five dollars per cord. The consumption of coal is so vastly increased that, notwithstanding the efforts of three able companies, during the present season, to bring into use the coal in this vicinity, the demand far exceeds the supply, as is proved, not only by the daily clearing out of all the coal in the yards, but also by the enhancement of the price from $3 per ton, which is remunerative, to $4, the present price. When the floating ice made it impossible to cross the Mississippi in the early part of this month, coal was worth $10 per ton in Davenport, thus proving that no supply was accumulated for such a contingency.

The estimated demand for the coal produced in this county, to be consumed in this vicinity, and shipped on the Mississippi river, for the year 1857, is as follows:

Rock Island and vicinity, 2,000 families, at 10 tons each	20,000	tons.
Davenport and vicinity, 2,000 families, at 10 tons each	20,000	"
50 steam engines, at an average of 300 tons each	15,000	"
Farmers in the county, 1,000 families, at 5 tons each	5,000	"
8 steamboats for 200 days in the year, at 10 tons per day	32,000	"
Demand in Muscatine	10,000	"
" Galena	10,000	"
" Dubuque	10,000	"
" St. Paul	10,000	"
Other towns on Upper Mississippi	10,000	"
Total	142,000	"

To supply this great demand, there is now delivered, by the Chicago and Rock Island Railroad, 100 tons per day, and by teams, ordinarily about 50 tons per day; but now, during this cold winter, almost every team in the county is put in requisition, and 150 tons per day are delivered in Rock Island and Davenport—crossing on the ice to the latter place—in addition to that delivered by railroad.

For the last week 75 teams per day have been loaded at Coal Valley, with an average of one ton each. As soon as the railroad is finished to Coal Valley, this great demand can be supplied at the regular and moderate price of $3 per ton.—*Rock Island Advertiser.*

EMPIRE COAL COMPANY.

The President and Directors of the Empire Coal Company report to the Stockholders the following as the condition and prospects of the company's property at the close of the fiscal year, ending December 1st, 1856. In September, 1854, a careful examination was made by Chas. F. Ingham, Mining Engineer, under whose supervision two trial pits were sunk, to fix the location

of lowest depression of the coal veins underlying the property, which resulted in the determination to open the mammoth, or 24 feet vein, by a perpendicular shaft, 11 by 18 feet in dimensions. Its location is about a mile from the borough of Wilkesbarre, in a very eligible position, in view of the engine house breaker, &c., at its top; admitting all the foundations on which the pressure from two 40 horse power engines bears to rest in solid rock. It is now sunk to the depth of 175 feet, most of which has been through solid rock, having passed through two veins of Coal, each of 6 feet in thickness, the last one at 130 feet from the surface; a slope was driven into it a distance of 30 feet to the sinclinal axis of the vein, proving that the shaft location is at the centre of the coal basin on our property. This fact will prove of much advantage in the future mining operations of the Company, as it will g've mining area on both sides of all tunnels diverging from it across the property, and driven in the coal veins cut through by the shaft; by this location, however, we shall have to sink deeper to get the 24 feet vein than we should have done at a point nearer its eastern outcrop, where we first contemplated; but, when reached, we shall drain about 75 acres more of it than at the first place selected, where we should most likely have struck the vein in a perpendicular distance of 100 feet. All the outside work pertaining to the colliery, such as lateral railway tracks, engine houses, miners' houses, &c., have been completed, and the timber prepared for the breaker, which will be erected the coming spring, and, unless prevented by obstacles not now anticipated, we shall be ready to ship coal by the first of May next. The accumulation of population at Wilkesbarre, as a centre, is gradually augmenting in value the surface right of the Company's lands.

LATERAL RAILROADS.

The following is the official quantity of coal transported over the different lateral Railroads in Schuylkill county in 1856:—

	1856. *Tons.*	Increase. *Tons.*	Decrease. *Tons.*
Mine Hill and S. Haven	1,592,421	75,469	
Mill Creek	626,275	10,421	
Schuylkill Valley	446,410		108,078
Little Schuylkill	454,515	28,307	
Mount Carbon	196,197	6,459	
Swatara	181,950	24,806	
Lorberry Creek	45,224		2,294
Mt. Carbon and Pt. Carbon	718,236		51,718
Union Canal (2,000)	185,273		

The coal transported over the Mount Carbon and Port Carbon Railroad, was received from the Schuylkill Valley and Mill Creek Railroads—and the coal transported over the Union Canal Railroad, was received from the Mine Hill, Swatara and Lorberry Creek Railroads. The tonnage, it will be observed, was increased on all the lateral roads in 1856, except the Schuylkill Valley, where the decrease is large, Mount Carbon and Port Carbon, and on the Lorberry Creek, where it is slightly decreased, but will be increased in 1857.

LITTLE SCHUYLKILL COAL TRADE FOR 1656.

The coal from this region was sent by the following operators:—

	Tons.
J. & R. Carter	86,586
Jones & Cole	79,701
Wm. Donaldson	76,823
Heston & Carter	60,119
R. Ratcliffe & Co.	61,746
Peter Bowman	30,984
Geo. Wiggan & Son	31,855
Wm. Levan	24,241
Little Schuylkill Co.	3,510
Total	454,515

Supply in 1855, 426,208 tons. The trade from this region can be increased from 50 to 75,000 tons in *1857, if a market* can be found for the coal.

ASHLAND COAL TRADE FOR 1856.

Sent by the following operators:—

Bast & Pearson	70,573
Conner & Patterson	59,041
Bancroft, Lewis & Co	59,081
George S. Repplier	57,066
L. P. Brooke & Co	26,614
E. Hammer & Co	24,165
Total in 1856	296,462

The quantity shipped from the Ashland region last year, was 125,495 tons. Increase in 1856, 170,970 tons.

The coal shipped by Messrs. Bast & Pearson, and by George S. Repplier, was from the property of the Locust Mountain Coal and Iron Company, amounting to 127,611 tons. The balance was from the Ashland estate, belonging to Brock & Co.

There was also shipped from the Locust Mountain Coal & Iron Company's lands, from Mt. Carmel *via* Shamokin, by Lewis, Muir & Co., and Beaver, Geddes, Marsh & Co., 24,019 tons of coal, making the product from the lands of the Company, 151,630 tons in 1856.

SHAMOKIN COAL TRADE FOR 1856.

The following is the quantity of coal shipped from this region by the different operators:—

Cochran, Peale & Co	31,584
Lewis & Co	14,665
Boyd, Rosser & Co	14,614
Zimmerman & Purcell	14,265
Ayres & Co	13,508
Beaver, Geddes, Marsh & Co	8,579
Ammerman & Weitzel	8,560
Fegeley, Seasholtz & Co	7,345
Seasholtz, Fegeley & Co	5,942
Bird, John & Douty	5,505
Mears & Davis	4,374
Ammerman, Zerne & Weitzel (abandoned)	3,020
Anthony & Co	1,858
J. B. Douty, (abandoned)	524

SWATARA OR PINEGROVE COAL TRADE FOR 1856.

The quantity of coal sent over the Swatara and Union Railroads in 1856, was as follows, tons of 2,240 lbs., 5 per cent. off:

From Donaldson and Tremont.

	Tons.
R. H. F. Horton	46,857
Brown & White	33,366
Clarke & Co.	12,805
L. S. Spangler	8,941
Fisher & Co.	8,203
L. S. Spangler, (Spohn vein)	3,133
J. Claude White	1,214
J. B. McCreary	370
Total	111,923

From Lorberry Creek.

Wheeler & Miller	29,055
Kitzmiller & Stees	12,003
Molly & Newcomer	4,171
Total	157,152

Of the above quantity 75,640 tons were shipped by canal from Pinegrove, and the balance over the Dauphin and Susquehanna Railroad, East and West.

The trade from the Swatara section of the region is rapidly increasing. It has the advantage of two markets, *via* the Dauphin and Susquehanna Railroad, west to the Susquehanna country, and the Baltimore markets, and east to the Philadelphia and New York markets.

PHILADELPHIA AND READING RAILROAD.

Points of supply and distribution of coal on the Philadelphia and Reading Railroad, for the year ending November, 30th, 1856:

Amount of Coal Received from Various Lateral Railroads in Coal Region.

	Tons.
Mount Carbon and Port Carbon Railroad at Port Carbon,	
From Valley and Mill Creek Railroad	658,267 07
Mount Carbon Railroad at Mount Carbon	123,321 14
Mine Hill and Schuylkill Haven Railroad at Schuylkill Haven	909,095 11
Dauphin and Susquehanna Railroad at Auburn	35,648 14
Little Schuylkill Railroad at Port Clinton	362,569 17
	2,088,903 03

Station or Turnout.	1855. *Tons.*	1856. *Tons.*
Port Carbon	209	9 00
Pottsville		462 01
Schuylkill Haven	201	387 07
Orwigsburg	42	42 00
Auburn	38	78 10
Port Clinton		12 02
Hamburg	445	225 17
Mohrsville	489	461 12
Between Mohrsville and Reading	2,507	2,308 00
Reading	77,364	106,131 17
Birdsboro'	706	290 17
Douglasville	872	941 15
Pottstown	8,986	11,587 19
Limerick	630	686 17
Boyer's Ford	924	1,248 05
Phœnixville	57,652	43,629 09
Valley Forge	370	371 01
Port Kennedy	6,519	6,715 17
Norristown	26,255	24,553 10
Rambo's Limekilns	3,397	3,215 07
Swede's Furnace, below Norristown	4,496	12,190 07
Conshohocken	37,349	36,566 16
Spring Mill	153	264 16
Manayunk	1,128	2,334 03
Falls	49,225	48,800 01
Nicetown and Germantown	14,095	25,849 00
Philadelphia Branch Road	537	186 08
Philadelphia	342,311	338,188 16
Richmond	1,576,596	1,421,213 04
Total	2,218,292	2,088 903 03

RHODE ISLAND COAL.

The coal mines of Portsmouth, Rhode Island, claim some importance. The Providence *Journal* says that the yield for the past year has been about 7,000 tons, and the whole quantity taken from the mines since the company commenced operations is about 60,000 tons. The quality of the coal has much improved the past year, and is said to be equal to the average Pennsylvania coal. It meets a ready sale, and the demand is now greater than the supply.

COAL MINED IN BELGIUM.

The total quantity of coal from all the mines of Belgium in 1855, was 8,958,416 tons, being about 1,431,000 tons more than the total production of the whole of France. The quantity extracted in England is more than 64,000,000 tons.

NEW GRATE BAR FOR BURNING COAL IN LOCOMOTIVES.

Mr. Wm. E. Darrah, of Newark, N. J., a practical engineer and machinist, has invented, it is said, a Patent Grate Bar for burning coal, coke or wood, in locomotives or stationary engines. It is a self-cleaner, and by the motion of the engine the draft is kept continually open. He has been experimenting with it on the Susquehanna division of the New York and Erie Road with great satisfaction. It appears to be a very valuable invention, as the great difficulty for substituting coal or coke for wood in locomotives, has been clinkering, stopping the draft, which is obviated entirely by this patent bar.

SCHUYLKILL NAVIGATION.

Points of supply and distribution of coal on the Schuylkill Canal for the year 1856:

From Port Carbon	347,900
From Mount Carbon	53,740
From Schuylkill Haven	679,567
From Port Clinton	78,267
Tons	1,169,456

Where delivered in	1855.	1856.
Orwigsburg	28 00	263 01
Hamburg	5,807 15	4,219 18
Mohrsville	1,467 09	1,351 10
Leesport	15,553 02	14,972 05
Felix's Dam	2,384 16	2,548 04
Reading	42,110 17	45,296 06
Birdsboro'	18,061 07	17,892 16
Mt. Airy	112 00	337 19
Port Union	510 00	435 00
Pottstown	615 00	735 05
Springville	206 10	498 00
Boyer's Ford	754 00	1,426 11
Black Rock	519 10	444 00
Phœnixville	16,884 16	20,585 06
Port Providence	481 05	478 00
Pawling's Dam	397 00	121 00
Brower's Landing	280 10	492 10
Valley Forge	96 00	175 09
Port Kennedy	4,494 09	2,592 00
Indian Creek		90 00
Norristown	23,491 17	23,887 19
Bridgeport	1,464 10	1,505 09
Plymouth Dam	10,212 00	9,435 00
Conshohocken	1,081 10	3,213 10
Spring Mill	23,760 17	26,540 04
Flat Rock	803 05	662 19
Manayunk	11,677 17	11,530 18
Philadelphia and south of	286,087 08	322,588 04
New York and vicinity	631,700 07	655,781 15
Total	1,105,263 08	1,169,456 06

IRON AND ZINC.

CAMBRIA IRON WORKS.

We extract the following from the *U. S. Railroad and Mining Register* of Philadelphia, relative to this successful company, believing it well worthy a place in these pages:

Among the great metal works which distinguish Pennsylvania as the Iron State, the large establishment owned by the Cambria Company enjoys, with those of highest rank, equal reputation. In truth, in some respects, they are scarcely approached by any similar works. Their location is at Johnstown, at the western base of the Alleghany mountain, at the *end* of the Allegheny Portage Railroad, and the *beginning* of the Western Division of the Pennsylvania Canal, which extends thence to Pittsburg, 103 miles.

The Pennsylvania Railroad, which descends the western slope of the Alleghany mountain, parallel with the Portage owned by the State, passes through Johnstown, and then deflecting southward, leads to Pittsburg and the Ohio river, 78 miles.

From the Cambria Iron Works, therefore, to Pittsburg, there is a direct communication by railroad and by canal. The completion of the Hempfield Railroad will open, via Greensburg, a direct communication to Wheeling, and

the completion of the North-western Railroad will establish a short route, via Butler and Castle, to Lake Erie at Cleveland.

These different routes, with their connections, penetrating all parts of the Mississippi valley, give to the Cambria Company unusual facilities for transportation throughout the vast basin over which an iron net-work is fast spreading, and in which iron rails, in increasing quantities, find a market.

The mineral and forest lands of the Cambria Iron Company comprise twenty-seven thousand acres, covering 42 1-5 square miles. These lands—which are mostly mountainous—abound in richest geological strata, including iron ore and bituminous coal, limestone and fire-clay, accessible by easy and cheap process, for the production of the most *useful*, if not the most *precious* of the metals.

The Company have on their lands eight blast furnaces—seven stacks in blast; their rolling mills contain eighteen double and twelve single puddling furnaces, being equal to forty-eight single puddling furnaces; the capacity of the works is about five hundred tons of rails per week.

In the year 1856, in the early part of which the capacity of the works was less than half their present capacity, thirteen thousand tons of iron rails were manufactured, being equal to an average weekly production of two hundred and fifty tons.

Of the railroads containing iron of Cambria Company manufacture, we will name the Alleghany Portage—Broad-Top—Pittsburg, Fort Wayne and Chicago—Pittsburg and Cleveland—Cleveland and Mahoning—Iron Mountain of Missouri, to which 4,000 tons have been delivered and 5,000 tons are yet to be delivered—Galena and Chicago Union—Pittsburg and Connellsville.

In reference to the quality of the rails manufactured by the Cambria Iron Company, an English iron manufacturer, travelling in this country, under date New York, 16th May, 1856, thus answers the efficient and enterprising lessees of the works:

Replying to your inquiry as to my opinion of the quality of the rails I saw manufactured at your Works, I may say that much as I have visited the iron works of South Wales and Staffordshire, I never saw any rails made that would at all compare to yours, except they were those of the last East India contract in England, and an extra price was paid for those of £2 per ton. In England, the rail is made almost entirely from puddled iron, with sometimes a top and bottom of No. 2; but charcoal iron is strange to any rail ever made in England, and I consider that English rails made as you make yours, could not be laid down here under $10 per ton more than the price of the ordinary run of exported rails.

At a meeting of the Stockholders of the Cambria Iron Company, held at their Office No. 123 Walnut-street, Philadelphia, on Tuesday, the 20th inst., the following persons were duly elected Directors to serve for one year:

Matthew Newkirk,
David Reeves,
John Brock,
G. Herberton Newkirk,
Horatio C. Wood,
Henry Musselman,
Richard Wood.

And at a meeting of the Board held 21st instant, the following officers were unanimously elected:

Matthew Newkirk, President.
David Reeves, Vice-President.
John T. Kille, Secretary and Treasurer.

BESSEMER IRON.

The Bessemer discovery has latterly been treated with a great degree of severity by many persons who have affected to be disappointed in the result of the discovery. In Manchester the feeling on this subject is somewhat strong, and a controversy has arisen. Several letters have appeared, but the most sensible and intelligent one that we have met with is from the pen of

Mr. W. Corbett, of Stockport. It was written in answer to one which had appeared expressing surprise that a gentleman of Mr. Fairbairn's high scientific attainments should have noticed it. The writer says: "When Mr. Bessemer made the discovery known, the nation was all dumb. In fact, to use the common phrase, Mr. Bessemer put them one on. They did not know what the result would be; but now they think it has proved a failure, they are all open-mouthed to run it down. They knew at first it would not answer. They knew this, and they knew the other; but the fact is, they knew nothing about it. There is not one of them who can tell what a piece of fibrous bar-iron consists of, nor how it is composed. Your correspondent admits he has had 26 years' practice. In my opinion he has made poor use of his time. He calls Bessemer's iron burnt iron. But it is impossible to run burnt iron into ingots. He must go a step further and form the oxide of iron, the well-known forge cinders; then he can run it into ingots, but he cannot well forge cinders into 3-4 round. I have seen Bessemer's iron rolled into 3-4 round, and it produced iron with a beautiful skin. Now, it is impossible to produce a beautiful skin on burnt iron. Let a man consider what burnt iron is, and what it is that burns it, and he will find it impossible to produce a fine skin from burnt iron. It appears that Mr. Bessemer does not know what a piece of fibrous iron consists of, else he would soon stop the nation from casting remarks on his invention. But if he does not go the whole hog and fulfil the conditions he promised, I shall class him amongst that race of short-sighted people that are seeking after perpetual motion. His invention has superseded the old running-out fire, and it can be very easily made to supersede the puddling furnace. Your correspondent is willing to give any information the trade requires. I wish he would be kind enough to inform me, 1st, What is the cause of iron being burnt? 2d, What is the cause of iron that is fibrous becoming cold-short when heated hot and suddenly cooled? 3d, What makes white cast-iron ring when struck with a hammer? 4th, What is the difference between cast iron and wrought iron?

The cause of the explosion at the Monk Bridge Iron Works near Leeds of a Bessemer refinery was inquired into on Wednesday, and it appeared to have resulted from too much water being allowed to run through the feed pipe, which found its way amongst the molten metal, and so caused the explosion.—*London Engineer, Jan.* 2.

COMPARATIVE ELASTICITY OF WROUGHT AND CAST IRON.

The mean ultimate resistance of wrought iron to a force of compression, as useful in practice, is 12 tons per square inch, while a crushing weight of cast iron is 49 tons per square inch; but for a considerable range, under equal weights, the cast iron is twice as elastic, or compresses twice as much as the wrought iron.

A remarkable illustration of the effect of intense strain on cast iron was witnessed by the author, at the works of Messrs. Easton & Amos. The subject of the experiment was a cast iron cylinder, 10⅝ inches thick, and 14½ inches high; the external diameter being 18 inches.

It was requisite, for a specific purpose, to reduce the internal diameter to 8½ inches, and this was effected by the insertion of a smaller cast iron cylinder into the centre of the large one; and to insure some initial strain, the large cylinder was expanded by heating it, and the internal cylinder being first turned too large, was thus powerfully compressed.

The inner cylinder was partly filled with pewter, and a steel piston being fitted to the bore, a pressure of 972 tons was put on the steel piston. The steel was "upset" by the pressure, and the internal diameter of the small cylinder was increased by full three-sixteenths of an inch; that is, the diameter became 8 11-16ths of an inch! A new piston was accordingly adapted to these dimensions; and in this the cylinder continues to be used, and to resist the pressure; the external layer of the inner cylinder was thus

permanently extended 8 1-50ths of its length. In fact, it can only be regarded as loose packing, giving no additional strength to the cylinder.

Under these high pressures, when confined mechanically, cast iron, as well as other metals, appears, like liquids, to exert an equal pressure in every direction in which its motion is opposed.—*Clark's Britannia and Conway Tubular Bridges.*

ZINCKING IRON.

Alex. Watt, editor of the electro-metallurgical department of the *London Chemist*, has taken out a patent for the following method of covering steel and iron with a coating of zinc. He dissolves 12 1-2 lbs. of the commercial cyanide of potassium in twenty gallons of rain water in a suitable vessel, and to this adds 5 lbs. of strong liquid ammonia. These are stirred together, and several large porous cells, like those employed in a Daniell's battery, are placed in it, and a strong solution—6 lbs. to the gallon—of the cyanide of potassium poured into each, until the height of this solution is on a level with the ammonia cyanide liquor outside. Several pieces of copper are now attached to a copper wire connected to the negative pole of a galvanic battery—some of these pieces of copper are placed in each porous cell. Several pieces of zinc are now immersed in the solution outside of the cells, and they are connected by the copper wire to the positive pole of the battery, which is set into action and allowed to continue until three ounces of zinc to every gallon of the solution, has been dissolved from the pieces of zinc immersed in it. This amount can be found out by measuring the liquid and weighing the zinc before the latter is immersed. The porous cells are now removed, and a solution of carbonate of potassa (5 lbs.) is added to the zinc cyanide and ammonia solution in the vessel. The bath is then stirred, and a white precipitate falls to its bottom. When this has subsided, the clear is poured off into another vessel, and is fit for use. The iron articles to be coated, are first plunged in a pickle composed of one lb. of sulphuric acid, and a half pound of muriatic (hydrochloric) acid in two gallons of water. This pickle removes the scale or oxyd; they are then rinsed in rain water, brushed with a hard brush and sand, and finally rinsed in soft water—all the oxides must be removed, and no grease or sweat from the hands allowed on them. They are now placed in the zinc solution described, and connected in the well-known way to the negative pole of a battery, when a zinc deposition on them begins at once. As soon as they are sufficiently coated they are removed, rinsed in warm rain water and placed in dry saw dust to dry them. They are afterwards rendered bright by a scratch brush, or gently scouring with fine sand and a soft brush.

This is a more expensive and troublesome method of zincking iron than that commonly practised of dipping the cleaned iron into a solution of sal ammoniac, and from thence into a bath of molten zinc covered with ground glass; but it may be superior to it. The zinc is liable to go on unevenly by the molten bath process, whereas it will be very evenly deposited by the electrotype process described. Iron plates and other articles can be tinned by the electrotype process, by using a solution of the chloride of tin; such articles will take on a coat of molten zinc, (if dipped into it,) on the top of the tin.

COATING IRON WITH COPPER OR BRASS.

In the latest London *Engineer* we find the following remarks on the subject, from which it may be inferred that the invention, if it really effects what is claimed for it, is of great practical importance. It is worth trying by our own manufacturers.

Some experiments upon the process of Mr. Tytherleigh (Birmingham) for coating iron with copper, have just taken place at the electro plate works in that town, of Mr. Edmund Heeley. It is truthfully remarked, that "hitherto it has been easy enough to deposit copper upon iron; but until Mr. Tyther-

leigh's discovery the combination of the two metals has not been so completely achieved as to permit of the iron, when coated, being rolled into any required thickness, or stamped into the innumerable forms occurring in the various stages of manufacture." The principle of the process adopted under Mr. Tytherleigh's patent is described as being analogous to that of soldering, the difference being that the granulated metal used in soldering is spread over the surface of the iron, instead of being merely applied to the edges which the workman desires to unite. In preparing a sheet of iron to be coated, the patentee first pickles or cleanses it; then he spreads evenly over the surface the common brass solder, and over this he spreads a quantity of borax, to act as a flux. The sheet thus prepared is placed in a furnace heated to the proper temperature, and, after remaining in the fire about ten seconds, is withdrawn, and permitted to cool—the brief time mentioned being sufficient to ensure the union of the metals. Iron thus coated has successfully borne the severest tests in annealing, rolling and planishing. After such trials, the brass has been found so firmly united to the iron that nothing short of actually filing it down effected a separation. By using a furnace with doors on opposite sides, and the adoption of the proper machinery, sheets of any size may be thus coated; and the process may be successfully performed on both sides of the sheets at the same time. To coat iron nails with brass and copper, the following is the process. The metal is fused in a crucible or other proper vessel, and the flux being added the articles to be coated are placed in the vessel. This process in its application to articles of so small a size as those mentioned, affords results equally satisfactory with those which attend the coating of sheets or flat surfaces. In the specimens shown during the experiments referred to, the coatin was not only firmly amalgamated with the iron, but was also bright and smooth; and it was only by the difference in the weight and strength of each of the different samples that the coated iron could be distinguished from brass or copper. It requires very little reflection to perceive the many advantages of such an operation as that of Mr. Tytherleigh's at a time in particular when copper is scarce and consequently dear. It is by no means improbable that the invention may be applicable to the sheathing for ships' bottoms. Many articles which are now made of brass or copper might be constructed with a foundation of iron. Strength, lightness and cheapness are amongst the principal advantages derived from the use of the new material. Then in respect of iron treated upon the principle of the patent, the danger that arises from oxidation would be completely avoided.

COATING SHEET IRON WITH VARNISH.

Messrs. Morewood and Rogers, of Enfield, England, have taken out a patent for covering sheet iron with a varnish, so as to protect it in a superior manner from the action of the atmosphere. They first take clean sheet iron plates, and dip them in a solution of the chloride of tin, by which they become covered with a thin scale of tin. They are then washed well in warm water, and dipped into a melted composition of two-thirds resin and one-third tallow, heated to 240° Fah. They are then allowed to dry, and afterwards dipped in a hot solution composed of three-quarters of a pound of shellac and one-fourth of a pound of resin dissolved in two gallons of alcohol. Any quantity may be made from these proportions. They are then taken out and dried in an oven. Common tin plates for roofing, exposed to sea winds, where tin is liable to rust, if coated as described, will stand exposure to the weather well.

FURTHER EXPERIMENTS WITH BESSEMER'S IRON PROCESS.

Dr. Stephenson Macadam read, at a late meeting of the Scottish Royal Society of Arts, some reports of experiments, which go to show that the pro-

cess is ruinous to the metal when carried on for a long period, but may be of service in partially decarbonizing the pig, in which case its use is analogous to that of the common finery fire.

A furnace was charged with 1,492 lbs. of No. 2 pig iron, and the air forced in at a pressure decreasing gradually from 15 to 5 lbs. per square inch, for 89 minutes, after which the scintillations still continuing, the furnace was tapped and the iron run into moulds. The quantity thus moulded together, with what was thrown out by the violence of the ebullitions, was only 630 lbs., showing 862 lbs. to have disappeared in the operation. On attempting to roll the metal it was "hot short," and no subsequent effort at annealing it was successful.

Another furnace was charged with 784 lbs. of No. 1 pig, and treated as before, but tapped after thirty minutes. The product or bloom was capable of being rolled, but was still, after re-heating and re-rolling, very crystalline and brittle. This iron was pronounced "cold short."

Another trial with No. 1 pig, treated twenty-four minutes, gave a result similar to the last. Nos. 1 and 2 iron contain more carbon, are more fusible, and more valuable than numbers 3 and 4, which latter are generally selected for converting, by the ordinary process, into bar iron. One trial was made with No. 5 iron, but in fifteen minutes the metal settled down in the furnace, and though it was immediately tapped, the iron would not run out, and the furnace had to be taken to pieces to liberate its iron prisoner.

As intimated above, good bar iron was made in the puddling furnace from iron which had been previously boiled a short time only in the Bessemer furnace. This latter experiment, as were most of the others, was at Coes' Malleable Iron Works, near Glasgow.

IRON MANUFACTURE AT LAKE SUPERIOR.

The *Lake Superior Journal* furnishes the following on this subject:—

The transactions in iron ore, for the past year, though small in comparison with what can and will be done, exceed by far the anticipation of those interested. The business has been commenced and the ore successfully introduced into market, where it sells readily at high prices, and all that is now needed is careful and judicious management to insure a lucrative and profitable business. The shipments for the year were, for the Cleveland Iron Mining Company, 6,536 gross tons, and the same have now on the docks ready for shipment, 3,500 gross tons, making a total of 10,036 tons mined; for the Sharon Iron Mining Company, 4,497 gross tons, and the same have now on the dock ready for shipment 2,805 gross tons, making a total of 7,302 tons mined; the exact amount taken out by the Eureka Iron Mining Company we have not been able to ascertain, but from our estimates which are probably liberal, they have shipped 2,000 gross tons, and have some 600 gross tons ready for shipment, giving them a total of 2,600 tons mined. The whole amount shipped being 13,033 gross tons, and the total amount mined 20,538 gross tons, which, at $5 per ton, the lowest price we have heard put upon it at the dock, would nett $102,690. The shipments may look small, but it should be remembered that this is the first really active season and was the finishing up of the experimental work. When this is taken into consideration, with the fact that the trade has been established upon a firm basis, it is highly gratifying. From the preparations now making by the companies already in operation, and by others, which will commence in the spring, we estimate the shipments for this year at 200,000 tons. This amount at the price before named would nett the various companies over $1,000,000! Those are large figures for a small town, yet they are short of, rather than over the truth, and are destined to be largely increased!

ARRANGEMENTS OF THE CRYSTALS OF CAST IRON.

Robert Mallet, an Englishman, the author of a work published in London, on Artillery, affirms that in the "molecular aggregation of crystalline

solids, the crystals always arrange and group themselves with their principal axes in lines perpendicular to the cooling or heating surfaces of the solid; that is, in the lines of direction of the heat wave." He assumes that, as a gum in cooling radiates heat from the centre outward in all directions, the particles arrange themselves in radial lines ready to be separated on the application of a comparatively slight force, thus possessing least strength in the direction where it is most wanted. He illustrates by the following experiment, which might be readily tried:—"If a cylinder of lead, some four or five inches long, and of about the same diameter, be cast around a cylindrical bar of iron about an inch and a half in diameter, and considerably longer, the lead, becoming rapidly consolidated by the contact of cold material interiorly as well as exteriorly, will have a tolerably homogeneous structure, and may be cut into, beaten out, &c., without exhibiting any trace of crystallization. But if one of the ends of the central bar be heated red-hot, and time be allowed for the heat to be conducted along into the interior of the lead, and thence conducted outward in all directions till the heat is nearly up to the melting point of lead—say to about 550° Fah.—and the lead be now sharply struck with a hammer, the whole mass will be found to have a crystalline structure, all the principal axes of the long thin crystals radiating regularly from the centre; and by a few blows of the hammer the mass will separate and fall to pieces, so complete are the planes of separation."

As a consequence of this law, it is inferred that every abrupt change in the form of the exterior of any casting, is attended by an equally sudden change in the arrangement of the crystals, accompanied with one or more planes of weakness in the mass. The small cast-iron cylinder of the hydraulic press used in raising the tubes of the Britannia Bridge, failed under the immense pressure, until another form was substituted with a bottom more rounded; and the theory laid down, and to a certain extent established by this writer, would seem to indicate that when angular forms are absolutely required in castings exposed to great strains, it might be expedient to cast the parts in rounded forms, and then turn or plane them to the forms required.—*Scientific American.*

JOURNAL OF GOLD MINING OPERATIONS.

CALIFORNIA GOLD FIELDS.

A very definite view of the mining operations in various districts of California at the present time, is presented in the following summary for which we are indebted to the *Bulletin of San Francisco.*

The general success of the placer miners this year has been quite equal to, if not greater than, former years, notwithstanding that in the early part of it, there was a great want of rain. New and rich diggings had been discovered, and those material adjuncts to the miner's success, canals, flumes and ditches, for the supply of water, have been enlarged to at least double their extent two years previous. We might cite this fact as one of the strongest corroborative evidences of the success of placer mining, the whole of those works being either the property of the miners themselves, or of those in their immediate vicinity, whose confidence in their practical utility is derived from personal knowledge and observation. We have heard the value of all these ditches and canals estimated at fully eleven millions of dollars, and yet they are all made with *bona fide* capital, and owned on the ground where they are constructed. Had these canals been the work of these Stock Companies, which

in other countries are sometimes guided only by the design to create an object of speculation on change, we should consider them less in the light of evidence of mining success; but the mere fact that they have been created with actual capital for practical purposes by the men most interested in their success, speaks volumes for their future utility. It must be borne in mind, also, that whilst these artificial water courses are largely extending the products of the placer mines, the expense of their construction not requiring to be re-incurred like the annual expenses of agricultural or other pursuits, the accumulation of the miners' profits, and we hope of home capital, will of course proceed in an increased ratio.

Of the annual product of the gold mines and placers of the State, it is difficult also to speak with any positive degree of accuracy. In the fire of May, 1851, almost the entire records of the Custom House were destroyed, together with a vast quantity of the books and papers of mercantile houses, so that we can only state the recorded amounts exported by the mail steamers and other vessels since that epoch, which were as follows:

1851 (8 months)	$34,492,000
Estimate other 4 months	11,497,000
	$45,989,000
1852	45,779,000
1853	54,965,000
1854	51,429,000
1855	45,183,000
1856	50,697,000
Total	$294, 042, 000

It is believed that the exports of gold of the previous years 1848 to 1850 may have amounted to $66,000,000. So that we have a total recorded export of about $360,000,000 since the first discovery of the precious ore. To all this should again be added the sums taken or sent away by passengers without record, or those irregularly exported. This it would also be difficult to ascertain; but were we to estimate the quantity at forty millions, we hardly think we should be much out of the way, making a total exportation of gold of four hundred millions of dollars.

But even this does not represent the total *product* of gold in the State. The accumulations of home capital among bankers and other men of business, the hoardings of the laboring classes, and even the sums worked up into jewelry would together form an amount of no small magnitude, all of which constitute part of the product of our rich fields and rocks of gold; but any attempt to form an estimate of these items would be entirely useless.

The following statement of some of these water companies will no doubt prove interesting.

Columbia.—Tuolumne County Water Company, capital $550,000 divided into 1400 shares. This Company furnishes 200 to 300 tom streams the year round, and with some improvements now making will be able to supply the miners during the dry season—an object of paramount importance. The whole length of the canal is 27 miles.

The Columbia and Stanislaus Water Company's Ditch, not yet finished, although they have been able to supply some water the past summer. The canal when completed, which will be it is supposed in July next, wil be 60 miles in length. Capital stock, $445,000.

Big Oak Flat and Garotte Ditch—40 miles long, not completed. Estimated cost, $250,000.

Tuolumne River Water Company, 60 miles long. Capital $400,000—now under repairs.

Shaw's Flat Canal Co.; 50 miles long. Cost 400,000—recently finished—will pay large dividends.

There are also ten other ditches in that county, costing from $1000 to $18,000 each, and from 2 to 15 miles long—one (Enterprise Co.) not yet completed.

BUTTE COUNTY.—We learn by a letter from Forbestown that "There are several ditches in operation and other new ones under contract intended to supply the miners in Frenchtown and Spanishtown, with a capital of $60,000. The West Feather and Thompson Flat Ditch, with a capital of $150,000, will furnish water to a large mining section." No further particulars are given.

ROUGH AND READY.—Deer Ditch; capital $25,000; dividends during the last year 3 per cent. per month.

Slate Creek Ditch; capital $15,000; dividends during the last year 2 per cent. per month.

Tri-Union Co.—Cost $50,000—has paid dividends during the past year a little over 3 per cent. per month.

All these three ditches have water in them only 6 to 8 months in the year; their length is not stated.

The Excelsior Water Co. is now two-thirds completed, and will cost about $150,000.

SHASTA.—Clear Creek ditch, 53 miles long, with a branch 27 miles long. Six reservoirs covering 30 acres, four feet wide at bottom, seven at the top and two and a half deep. Value $300,000, and pays dividends at the rate of 2 per cent. per month.

Our correspondent at Downieville sends us a list of eighty ditches in operation in that county, costing from the small sum of $300, to $70,000 each, and forming in the aggregate a capital of $453,550, which is a very large amount to be invested in any one county. His letter adds as follows:

"These valuations are taken from the assessors' Books, as I have no means of ascertaining their actual cost nor their regular dividends. They are, however, all paying well on their investment, and on some of them the annual dividends are equal to the assessment! They are mostly situated on the ridges, and dependent on the snows for their supply of water, and are therefore available but a few months in the year. The mining riches of this region are equal to any in the State, our only drawback being the want of water. The deep or tunnel diggings are very rich, and although only opened in a few places, are being rapidly prospected. The river mining this year has been more profitable than it has been since 1853."

From Yankee Jims in Placer Co. we learn that the Ditch Companies in that vicinity are as follows:

The Yankee Jims Union Water Co. formed by a combination of two other Companies in 1853, the capital stock being $128,000, divided into 128 shares; but the competition of other Companies has reduced the value to $125 per share.

The Miners' Ditch; it is just finished—no dividend thus far; it cost $30,000.

There are besides several small ditches dug and owned by some miners themselves, who frequently dispose of the water to other miners.

From Nevada our correspondent writes as follows:

"There are now over 700 miles of canals and ditches in this county, costing probably not less than five millions of dollars; and more will be added this season, as the supply of water is still inadequate to our wants. But although it is believed that these works yield large profits, no publicity is given to them, as they are generally held by a few individuals who choose to keep their own business to themselves. All the water in the State could be used, if brought here, as, there are miles upon miles of rich ground lying undisturbed, and must continue so until this desideratum is supplied."

From Vallecito we have the following information:

"There are three ditches in this vicinity, viz.;

"The Vallecito and French Camp Ditch, cost $15,000, completed last season, and has made no dividends, but is expected to pay 3 per cent. per month.

"The Indian Gulch Ditch is valued at $6000, and has paid from 4 to 6 per cent. per month on the capital invested for the last four years.

"The Vallecito and Carson Ditch is just completed, at a cost of $80,000, and promises to be a good investment."

From Knight's Ferry we have the following:

"The most extensive work now finished and in operation is the

"San Joaquin County Water Co.'s Ditch, 10 miles long; estimated to cost $40,000, but the cost was eventually $90,000. It has been in operation since the 1st of April. Its average receipts were $1200 per week for 35 weeks, or $42,000 per annum." Nothing is said about the rate of dividends.

The Knight's Ferry and Table Mountain Water Company's Ditch is in course of construction by a Joint Stock Company; estimated cost, $80,000. Capital of the Company, $110,000.

Parsons & Buddington's Ditch cost $6,000, and yields $100 per week.

The Mountain Brow Water Company's Ditch, 6 miles long, established—to cost, when finished, $7,000.

From Sacramento County we have the following: There are seven principal canals, with an aggregate of 118 miles, conveying and distributing water for mining purposes.

Original cost in this county	$130,000
Annual income	$338,000
Annual cost of repairs and superintendence	68,000
Net income	$270,000

From Placer County we learn that there are twenty-four Canals and Ditches there, varying in assessed values, from $200 up to $130,000 each, and constituting an aggregate capital of $339,100. But the actual cost of only six of these Canals and Ditches is said to have been $1,228,000, and they are assessed at the above low range from their comparatively unproductive character, the greater part of them having been constructed when labor and materials were at very high rates. They have, however, been of immense value to the county, as, without them, the mining business would have been extremely limited.

From Grass Valley we learn that the chief water conveyance there is the Empire Ditch, 3½ miles long, costing $10,000; Murphy's Ditch, 2½ miles long, cost $3,000; the Union Ditch 4½ miles long, costing $10,000. The first two pay about 4 per cent. per month dividends. The third is uncertain.

There are many other canals and ditches in the country, but we have mentioned all of which we have any reliable knowledge. Their importance to the dry diggings it would be superfluous to comment upon; but it must be obvious that with all those vast adjuncts of mining operations so recently sprung into existence, the products of the placer mines must greatly surpass those of the years '51 to '54, which are estimated to have been equal to fifty millions per annum. We are confirmed in this belief from our advices from the interior which represent the prospects every way flattering, with already quite copious supplies of rain.

The leading object of interest now, however, among miners, is the Quartz rock, which, although it very early attracted the attention of European miners and capitalists, yielded but meagre practical results. This was owing chiefly to their inadequate machinery, their defective organization, and the incredible and unexpected expenses incident to their whole operations, in the early days of the State. More recently, however, practical and experienced miners have entered vigorously into the business, all with some degree of success, and many of them obtaining a remuneration far beyond their expectations. It appears to be the general belief, that according as the "science"—it is such in comparison with placer mining—of quartz mining becomes thoroughly understood, it will form the chief pursuit of miners generally.

We make the following note of some of the leading Quartz Mills and works in the State.

COLUMBIA.—The experimental Mill, capital $3,200. Thus far unproductive. New veins just discovered, and prospects good.

Brown's flat, (arastra,) has yielded $2,200 to 9 tons of the rock.

Paterson & Co., (arastra,) has yielded generally $90 per ton.

WATSONVILLE, SANTA CRUZ COUNTY.—Independent Mining Company: started with $2,000 capital, and is extracting 75 ounces per week; value $13 per ounce, much silver being mixed with it. No further particulars given. Another company is about being organized to work a lead just discovered.

TUOLUMNE COUNTY.—There are two mills, the "Tuolumne," and the "Enterprise," which have suspended for want of means. One, the "New York," which had also suspended, but which renewed operations—result not known. "Big Oak Flat" has done but little for want of water. The ore is very rich. Heslip & Yaney's mill not completed. Ore yields $40 per ton. "Caroline Mill," the ore yields $90 per ton sure. Allen & Co., the ore yields $90 to $120 per ton. No further particulars given.

SHASTA.—Washington Quartz Mill—water power; has been running 4½ months this year. Capital $28,000, but they have expended $62,000 more in improvements. In one period of five days, the yield was $4,646, but the amount per ton is not stated.

From Downieville our correspondent writes as follows:

"There is but one quartz mill in operation in this county, two nearly completed, and several others in contemplation, as there is a number of quartz ledges in the vicinity which promise to be of great value. The one in operation is said to be yielding largely, but I could obtain no precise information on the subject."

From Placer County we have the following: Near Ophir are three quartz mills, viz:

Empire (Steam) Mill—cost, $7,000; works 10 hands; crushes 20 tons per diem and yields $1,000 per diem.

Union (Water) Mill—cost, $6,000; works 14 men: crushes 16 tons per diem and yields $800 dollars per week. Has not yet got fairly to work.

Naylor (Water) Mill—cost, $1,000; works 4 men, and crushes 6 tons per diem. Value of yield not stated.

From "Yankee Jim's," (Placer County,) we learn that the only quartz mill in that vicinity is that of H. H. Watson, established in July, 1855, on a capital not exceeding $5,000. Works 14 to 20 men; steam power; expenses $400 to $550 per week. Yields $500 to $2000 per week. Rate per ton not stated.

From Nevada we have the following:

"I know of but two quartz mills in operation above this, viz:

"The 'National,' at Eureka South, driven by water, and thus far not very successful, although the gold that *is* taken out is said to be the best in the country, selling at $18 25 per ounce. No further particulars stated. The other mill is said to be of little importance."

From Vallecito we hear as follows:

"There are three quartz mills in this vicinity, which have met with moderate success, having paid from $4 to $5 per day to the hand. They are on a moderate scale, and worked by horse power, the capital not exceeding $300 each."

From Sacramento County we hear as follows:

"Several rich quartz leads have been opened in the vicinity of Prairie City, Wall's Diggings and Carson Creek, two of which are now being worked with inferior arastras, and produce from $20 to $30 to the ton. Arrangements are now in progress for erecting steam mills, and working them upon an extensive scale."

The most extensive operations in quartz are conducted in Grass Valley, where also is to be found the "Alison Ranch" lead, supposed to be the richest in the world, yielding from $250 to $500 per ton. It is the property of six men only, who purchased the ground for a comparatively small sum, and are now reaping unheard-of profits. "Since their mill started, on the 1st October, they have taken out from $20,300 to $50,000 per week, and there is no apparent falling off in the richness of the ore."

There are altogether eleven steam and two water-power quartz mills in Grass Valley, exclusive of the one of the Alison Ranch, which yield, at the lowest, $5 and at the highest, $200 per ton. The whole country around contains quartz rock, and we are assured that capital, experience and judicious management are alone necessary to make all these mineral riches of tangible value. A gentleman of superior intelligence, and possessing the best opportu-

nities for observation, remarks that the present existing mills and machinery would not crush out the rock known to exist in the valley in a century.

We had endeavored to ascertain the number of miners, of all kinds, in the State, but without success. We will, however, remark that in their habits and character they have greatly improved, since the early mining times of 1849-50. They realize less profit, because so many more of them are spread over the same breadth of ground, which makes them more careful, with less of the former reckless expenditure of their earnings, in dissipation or extravagance. All this is the better for the character and welfare of the State, which would be less benefited by the sudden enrichment of men of rude habits, and the results that would inevitably follow.

Many miners now work for others, or for the quartz mills, at $3 to $5 per day wages, and good steady sober men will always find employment at these rates.

JOURNAL OF COPPER MINING OPERATIONS.

FLINT-STEEL RIVER MINING COMPANY.

The late report of this Company presents the state of operations up to the close of the last active mining season.

In their printed circular issued to the Stockholders on the 28th June last, your Directors stated that the works originally opened on the Flint Steel vein, and actively prosecuted thereon up to that time, had not realized the expectations that had been formed of them, but that a continuation of the Minnesota South vein had recently been traced upon and across the Company's location, about 400 feet farther South, and the conglomerate unmistakably exposed at several points. That this discovery, from the known richness of the same vein at the neighboring Minnesota and Rockland mines, gave reasonable encouragement to expect a similar favorable result from working at *this* point, and that your Directors had therefore suspended the old work for the present, and commenced the sinking of two shafts on the newly discovered vein—which *new* work it was their intention to prosecute with all possible energy, with the assessment of one dollar per share then called in.

Your Directors have further to report, that the said new work has been steadily progressing under the general direction of our Agents, Messrs. Roberts & Townsend, and the immediate superintendence of Captain Henry Richards; and with regard to its condition and prospects, the latest and fullest information on the subject is furnished by the following official report, recently made by Mr. Roberts to your Directors:—

Mr. Robert's Report.

"On the 28th May last, I arrived at the Flint-Steel Mine, and, under the instructions of the Directors, made an examination with a view to determine whether to advise the continuation or abandonment of the work at that point, as appearances, in connection with what had been previously produced, might seem to indicate or warrant. I found the extent of openings at that time to be as follows, to wit:—

Shaft No. 1	210	feet in depth.	Total Sinking, 588 feet.
Shaft No. 2	315	"	
Winze, from 10 to 20 fathom Level	73	"	
Adit Level	736	"	Total Drifting, 1,369 ft.
10 fathom Level	368	ft. in length.	
20 fathom Level	197	"	
Cross-cut to vein South	73	"	

"During the previous winter various parts of the mine, where the vein was sufficiently promising to warrant it, had been stoped and examined to prove its productiveness; but the result was not considered favorable enough to justify a continuance of the work. The vein in places is regular, but as a general thing producing only stamp-stuff, while the ground is hard and expensive to work. There is now a considerable quantity of stamp-work on the surface, not available at present, but which may be made so hereafter.

"In the progress of the operations at the Minnesota and Rockland mines during the last three years, the rich developments made on a vein lying next to the conglomerate, commonly called the "Minnesota South Lode," have given great confidence in its productiveness, and led to its exploration and examination throughout the whole length of the range from the Ontonagon to the Flint-Steel rivers; and especially that part of it which crosses this Company's property, about 400 feet south of the old work. On deciding last summer to suspend further operations on the north vein, the mining force was immediately transferred to the south vein, and commenced opening two shafts and an adit thereon. The shafts are located near the line of the Superior Company's tract (lying between this and the Rockland mines) about 200 feet apart; and the adit will cut the vein about 450 feet east of the most eastern shaft, and will connect from that point to the shafts—thus opening upon the vein a length of about 700 feet, giving a back at the shafts of near 200 feet, and affording drainage to the same depth.

"The adit, at last advices, had cut the vein, and the shafts were down 120 feet each; and it is expected they will be connected during the ensuing summer. The vein is regular, and of about the same character as at the Rockland mine, though not, as yet, so productive of copper. We cannot expect at present any definite information or form any reliable estimate of its probable value from the extent of work yet done—but from the well known character of the vein, and its productiveness at other points throughout its range, we may reasonably, if not confidently, expect favorable results when a greater depth and extent are attained in the openings. Its proximity to the old mine enables us to make advantageous use of all the old surface improvements. The whims and other machinery have been removed from the old to the new work, and tram-ways laid in the shafts to use wagons in place of buckets, which so far work well, and are considered a great improvement for inclined shafts.

"On the whole, I consider the work as laid out and now being prosecuted, well calculated to fully prove the vein at this point during the present year, and with all the economy consistent with the accomplishment of that object."

Your Directors cannot yet report any considerable available product of copper from the new works now in progress; but such a result can hardly be expected until a greater depth is attained in the shafts, and necessary connections made with the adit level. Only 2,113 lbs. barrel copper, taken from the shafts themselves, were forwarded before the close of navigation; but the large quantity of stamp-work besides already obtained, cannot, of course, be made available at present, though valued at some $3,000 to $4,000. The cost of improvements made, viz:—buildings, roads, clearings, &c., and our inventory of personal property, supplies, tools, and materials on hand at the mine amount in the aggregate to about $9,000.

With regard to the financial affairs of the Company, the following statement, made up from the books and the Treasurer's cash account, shows the

amount of receipts and expenditures, and about the balance of our present indebtedness:—

The amount of the Company's indebtedness reported in our last Annual statement, May 1, 1855, was		$11,430 56
Since which our expenditures, both for the old and new works, to 1st December last, have been		33,737 14
		$45,167 70

Towards payment of which have been applied the following receipts, to wit:—

Cash balance on hand May 1st, 1855	$466 52	
Balance of assessment Nov. 10th, and interest	493 77	
Sales of 1,000 Shares Stock	4,500 00	
Assessment of April 20th, 1855	10,000 00	
Assessment of July 21st, 1856	20,000 00	
Sales of Copper, 1855	372 66	
		$35,832 95
		$9,334 75
Additional expenditure estimated for December and January (returns not yet received), say at $1,250 per month		2,500 00
Making our whole indebtedness on 1st instant, about		$11,834 75

As this indebtedness must be immediately provided for, as well as means for continuing the work through the year, your Directors have called this Special Meeting (in anticipation of the usual Annual Meeting in April) for the purpose of acting promptly in the matter; and with that object they would recommend, as all previously authorized assessments are exhausted, that two dollars per share be now levied on the capital stock, subject to the call of the Directors as it may be required. With this additional expenditure at the farthest, your Directors will yet hope to congratulate their fellow Stockholders, at their next Annual Meeting, on the development of a good mine on the *new* vein, notwithstanding the discouragement hitherto attending our operations on the *old* one.

(Signed)

CHARLES E. SMITH,
WILLIAM PEARSALL, Jr.
DAVID S. MANNERS,
JOHN BODINE,
EBENEZER BEADLESTON,
WILLIAM K. CORNWELL,
} Directors.

On motion the Report was accepted—and a resolution unanimously adopted levying an assessment of two dollars per share on the capital stock, subject to the call of the Directors as may be required.

And at a meeting of the Board of Directors, held on the 13th day of February inst., an instalment of one dollar per share was called in on account of the above assessment, payable on or before Tuesday, the 10th day of March next. By order of the Directors,

SAMUEL J. W. BARRY, Secretary.

MISCELLANIES.

OPERATIONS OF THE MINT, THE ASSAY OFFICE, AND THE BRANCH MINTS.

It appears from the Report of the Directors of the Mint that the operations at the several mints and the Assay office, during the last year, was as follows:

At the principal mint the deposits were—in Gold, $7,479,568; silver, $1,730,-917. Total, $9,210,485. The coinage amounted to $14,346,762 99, comprising $11,074,388 12 in gold; $3,245,268 09 in silver, and $129,106 78 in copper coins, and composed of 26,870,288 pieces.

The coinage largely exceeds the deposits. This arises from the fact that the operations of coinage were suspended several months of the year 1855, during the progress of the work done at the mint to render it fire-proof, and to give additional security to the funds deposited in its vaults. The bullion then received has been coined down the last year.

The deposits and coinage at the branch mint at New Orleans, during the year, were as follows: Gold deposits, $310,935 67; silver deposits, $2,668,-803 02. Total deposits, $2,979,288 69. Gold coinage, $292,750; silver, $1,744,000. Total coinage, $2,036,750, comprising 952,850 pieces.

The Branch Mint at San Francisco coined of gold deposits, the sum of $29,209,218 54; of silver, the sum of $246,752 92. Total deposits, $29,455,-971 16. The operations of coinage were as follows: Gold coin, $25,146,000; silver coin, $177,000; refined gold bars, $122,136 55; unparted or unrefined gold bars, $3,047,001 29. Total operations of coinage, including bars, $28,516,147 29, comprised in 1,977,559 pieces.

The deposits received at the Branch Mint coinage was $102,575. The number of pieces struck, 22,120.

At the Branch Mint at Charlotte, N. C., the sum of $173,592 53 was deposited. The coinage amounted to $162,067 50; composed of 36,370 pieces. The operations of the branches at Dahlnega and Charlotte are confined to gold.

The Assay Office at New York received, during the year, gold deposits, $17,803,692 40, and silver deposits, including purchases, $474,161 38; total deposits, $18,277,853 78.

These deposits were paid for as follows: In fine bars, $13,094,386 36; in coin, $5,183,467 42. The number of gold bars prepared and stamped at this office was 4,729, of the value of $19,396,046 89.

MANUFACTURE OF SALTPETRE.

Mr. George Lurig, of Paris, has recently patented some improvements in the manufacture of artificial saltpetre, which appear calculated to cheapen the cost considerably. The invention consists in manufacturing saltpetre by treating, in the manner subsequently described, the common potash of commerce (carbonate of potash); sulphate of potash; nitrate of soda and quick lime.

The proportions of the above materials used in this process are as follows: 60 lbs. carbonate of potash, 40 lbs. sulphate of potash, 140 lbs. nitrate of soda, 180 lbs. quick lime. These quantities of carbonate and of sulphate of potash and of nitrate of soda are placed together in a large boiling pan or kettle, with enough water to dissolve them, heat being applied. When the liquor after boiling for some time comes to mark 20° Beaume's saltareometer, the fire is stopped, and the 180 lbs. of quick lime above mentioned, being placed in a tub large enough for that purpose, the solution is poured from the boiling pan on the quick lime, which is dissolved by it. As soon as this result has been attained the mixture is stirred for a few minutes, in order to get the compounds perfectly mixed together. After allowing it to settle for three or four hours, the lime gathers to the bottom, the superincumbent liquor is drawn off into a boiling pan of suitable dimensions prepared for that purpose; but as the alkaline salts cannot be taken up from the lime by the first drawing, a fresh quantity of water is poured into the boiling pan or kettle, and the same operation is repeated as at first; the liquor being stirred up again and left to settle, it is then drawn off as before, and this second is mixed in the boiling pan with the first. The fire is then kindled under the boiling pan or kettle containing the above drawn off liquors, which are boiled down till they mark 25° of Beaume's

areometer. When the solution or lye thus prepared has attained this degree of concentration, it may be used for making hard soap of any kind, and it is only after the alkalies have been separated that the saltpetre is manufactured. Thus, for manufacturing the soap, the sediment in the boiling pan is taken out, whilst for manufacturing saltpetre the liquor is drawn off and carried into another boiling pan, where it is boiled down till it marks 33° Beaume's areometer; the liquor is then left to stand until it is lukewarm, and it is run out into a tub prepared for its reception, where it is left at rest for 24 hours.

At the end of that time the mother liquor is drawn off from the crystals produced, by means of a cock or otherwise, and all the crystals deposited over the sides and bottom are saltpetre; the mother liquid, however, contains more saltpetre still, but as it is not strong enough to yield it by crystallization, it should be concentrated anew; it is accordingly poured out again into the kettle or pan and boiled down till it marks 33°, when the same process as before described is repeated. All the liquors which have been submitted to the above process may yield a residue of saltpetre.

Saltpetre may also be manufactured with the same materials as before stated, mixed together with the following proportions: 70 lbs. carbonate of potash, 40 lbs. sulphate of potash, 110 lbs. nitrate of soda, and 180 lbs. quick lime. Saltpetre is obtained by this process, following the same method as in the first instance; the liquor should, however, be boiled down a longer time in order to concentrate it to 42° instead of 33° of Beaume's areometer, as in the first process.

In order to obtain crystallized saltpetre by this method, as many drawings off as possible should be effected, that is to say, until the liquor concentrated to 42° fails in giving crystals by cooling; the remaining liquor is only a solution of potash, with which all kinds of soap can be manufactured, or from which refined potash (pearlash) can be obtained. All the alkalies, alkaline sulphates, and nitrates may be used in a similar manner for obtaining saltpetre by the methods described.

THE LEAD MANUFACTURE.

The manufacturers whose raw material is Lead, such as tubes, paints, &c., are petitioning Congress for a repeal of the 20 per cent. duty on pig lead, owing to the diminished production of our own mines.

The annexed table shows the total product of Lead and the average yearly price at Galena.

Years.	*Pig Lead.*	*Wt. per Pig.*	*Total lbs.*	*Price.*
1842	447,909	70 lbs.	31,353,630	$2 24
1843	559,261	70	39,148,270	2 84
1844	624,072	70	43,727,040	2 80
1845	779,498	70	54,494,360	2 96
1846	732,403	70	52,268,210	2 89
1847	772,656	70	54,085,920	3 17
1848	681,969	70	47,737,830	3 24
1849	628,934	70	44,025,380	3 67
1850	568,589	70	39,801,230	4 20
1851	474,115	70	33,188,050	4 18
1852	408,628	70	28,603,960	4 12
1853	425,814	70	29,806,980	5 50
1854	423,617	70	29,653,190	5 50
1855	430,865	70	30,125,556	5 75
1856	Estimated 25 per cent. less than 1855.			6 00

The following tables show the quantity of Lead of Western production received in the port of New-Orleans from 1844 to 1855 inclusive, and also of foreign Lead, paying 20 per cent. duty, imported into the port of New York from 1849, the first year of late importations of this staple, to 1856, both inclusive.

Western Lead received at New-Orleans and mostly forwarded to Northern cities, U. States.

Years.	*Weight, lbs.*
1844	44,746,830
1845	51,448,750
1846	54,977,580
1847	45,509,080
1848	36,487,620
1849	35,598,990
1850	29,078,000
1851	22,785,350
1852	18,729,480
1853	14,720,090
1854	2,450,000
1855	3,000,000
1856	1,800,000

Foreign Lead imported into New York.

Years.	*Weight, lbs.*
1849	23,475,000
1850	30,004,240
1851	43,464,120
1852	33,451,000
1853	37,913,160
1854	55,948,900
1855	40,927,140
1856	52,281,680

Estimating the American Lead to weigh 70 lbs. each pig, and the foreign 140 lbs. each, which is deemed about the average of each.

Lead received at St. Louis from Western Mines:

1854	306,827 pigs, or 21,470,890 lbs.
1855	315,677 pigs, or 22,097,390 lbs.
1856	204,656 pigs, or 14,325,920 lbs.

In 1844 the Galena mines produced 54,494,800 lbs. of Lead, and the price at St. Louis was about 3c. per lb. In 1856 they landed at St. Louis 14,325,920 lbs.—less than one-fourth the supply of twelve years previous, and the price was about 6 1-4c. per lb., thus being more than doubled.

In 1854 there was imported into the single port of New York, 55,945,900 lbs. of foreign Lead—more than the Galena mines ever produced in any one year.

Doubling the price, doubling the demand, has reduced the production to one quarter; and it is certain that in 1857 the Western manufacturers of Lead will have to procure a portion of their staple from imported foreign Lead in the Atlantic cities.

TO PURIFY GRAPHITE FOR LEAD PENCILS.

"To purify graphite," says the author of the above-named work,* "I made numerous experiments, and with great success. The best mode is to mix pulverized graphite with very strong sulphuric acid. The mixture gradually acquires a high temperature. After 36 hours it is washed, and the graphite thus obtained is of superior quality, and makes excellent and cheap pencils.

"The pound of English graphite costs in Berlin $1,85, and a pound of Spanish graphite only costs 8 cents: when the latter is treated with 4 pounds of sulphuric acid (at 3 cents a pound), it gives $\frac{3}{4}$ of a pound of graphite, which is as pure as the English. Those who employ this mode of purifying the Spanish graphite on a large scale, will do well to manufacture green vitriol at the same time, whereby the cost of sulphuric acid will be nearly covered.

MINERAL WEALTH OF GREENLAND.

An expedition to test with care the mineral resources of Greenland, has been arranged to start from Portsmouth this week. Some time back, the King of Denmark granted to Mr. Lundt, a Danish traveller, the right of mining in that country, where he is understood to have made extensive discoveries; and Mr. Albert Robinson and others, who have become interested in his privileges, have consequently fitted up a yacht of 217 tons, called the *Dolphin*, for the purposes of full exploration. She takes out several scientific men engaged for the undertaking, and the mines to be investigated consist of copper, tin, silver and lead.—*London Mining Journal.*

* Runge's Chemie, vol. 1.

THE

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VOL. VIII.—MARCH, 1857.—No. III.

ART. I. — THE IRON MANUFACTURE OF GREAT BRITAIN — THEORETICALLY AND PRACTICALLY CONSIDERED. By WM. TRURAN, C. E. No. 14.

(Continued from page 122, Vol. VIII.)

WHEN the pieces of pig approach a red heat the puddler directs his attention to their position, those in the remote parts of the furnace are shifted forward to the hottest, and *vice versa*—the object being to bring the different pieces simultaneously to the melting point; for unless this is accomplished the waste of iron and loss of time will be considerable.

The working door is made fast by tightly wedging it in the frame. In from 22 to 25 minutes after charging, depending in a measure on the qualities of the coal and the character of the iron under conversion, the edges of the pigs begin to melt; in another 5 minutes they are softened, and apparently adhering to each other and the bottom. The puddler raises them off the bottom, turns the uppermost pieces over to expose them equally to the heat and prevent their adhering together, which would obstruct their reduction. In this stage it is common to charge two or three lumps of coal next the flue bridge, and about 15 lbs. of cinder for the protection of the brickwork in that quarter. Thus far the fire has been urged to its utmost power, the second hand adding fresh fuel every few minutes and maintaining a clean grate for a free draught.

In 30 minutes after charging, the iron is all melted, and the most laborious operations of the puddler commence. The rabble is introduced, raking up the fluid iron fore and aft, and raising the lowest to the surface; at this point of the conversion the energies of the puddler and his helper, or second hand, are taxed to their utmost, both assiduously laboring at the raking up and stirring of the molten iron.

The evolution and expansion of the gaseous carbon augment the bulk of the mass, which spontaneously rises several inches, and apparently begins to boil violently; its surface is dotted with innumerable eruptions, caused by the ascent through the semi-tenacious cinder of gaseous matter from below. In about 5 or 6 minutes after the iron begins to boil the damper is partly closed,

checking the draught and lowering the heat within the furnace. The effect of this reduction of heat is immediately seen—the iron is evidently thicker and more pasty; now too it adheres to the tools and has to be removed by a hammer. At this stage "fermentation" commences, and the iron is said to be "coming to nature." The raking up the iron from the bottom is continued, the small door opened, and the parts next the flue turned over along with the rest. By thus constantly raking and working the iron, the puddler prevents the adherence of any portion to the cold bottom, and facilitates the escape of the gaseous carbon; great care, however, is demanded in the management of the cinder, especially at the commencement of the process; for while it is necessary that it be such as will protect the iron from wasteful oxidation, it may not by too great consistence retard the ascent of the carbon. Hence, the skill of the operative is directed to the separation by oxidation of the carbon; for which purpose every portion of the charge under treatment is brought to the surface and exposed to the oxygen of the passing current; and to the attainment of this objcet in the shortest period; thereby ensuring a minimum loss of iron through oxidation.

The working of the boiling metal continues for about 18 minutes, at the end of which time the semi-fluid iron has the appearance of a quantity of frozen snow. The continual raking motion has resulted in the evolution of the gaseous carbon and the separation of the iron from the cinder, which now flows over the bottom apparently as liquid as water.

The period for balling-up arrives; a few pounds of wet scales from the cooling bosh are thrown in; their introduction causes an immediate reduction of temperature, which is improved by the puddler in bringing the iron farther towards the pasty condition desired. After 8 or 9 minutes' raking of the iron now in the condition of pasty lumps, which require to be constantly stirred to keep them from running back to the form of boiling iron, the puddler commences the formation of the puddle balls. The number produced will depend on the charge, and ability of the operative; 5 or 6 is usual, but 7 and 8 may be seen brought out. The puddler commences by collecting together such a quantity of the pasty iron as he conceives will suffice for a ball, placing it a little aside in the furnace; he proceeds with the others in like manner, keeping his iron together and shaping the balls by the help of the leverage which he has with the iron bars employed, the slot in the door acting as a fulcrum. When they have been roughed-out the damper is lowered, that, in their finishing, the heat may not be such as to cause an unnecessary waste of iron.

The puddle is now ready to "come out;" the wedges around the door are driven back, and the balls extracted; this occupies about 4 minutes. From charging the first piece of pig to the extraction of the last ball the time occupied in the process, with

good workmen and a fair coal, will average 1 hour and 20 minutes; with inferior hands and a less inflammable coal, 1 hour and 50 minutes is under the average. If it is performed in 80 minutes, as we have described, a puddler and his helper will easily boil 8 heats in the 12 hours, producing, with charges of 4½ cwts. each, 32 cwts. of boiled iron bars daily, or 9 tons 8 cwts. weekly, making for the entire produce of the furnace 18 tons 16 cwts., or 20 tons 3 cwts. legal weight weekly.

On the withdrawal of the puddled balls a quantity of cinder remains on the bottom; a portion is tapped below the working door before charging a fresh heat. The cinder, beyond the quantity charged, and the minor quantity resulting from the fusion of a portion of the material composing the furnace, is produced by the oxidation of a portion of the iron and metalloids in alloy; it contains a large percentage of silica, and if not frequently renewed, will ultimately possess such a quantity as would unfit it for the protection of the iron: by tapping and replacing with an inferior quantity of other cinder from under the mill rolls, the puddler prevents the increase of silica, and obtains a fluid fusible cinder, rich in iron.

Boiling crude iron runned direct from the blast furnace is practised to a limited extent. By operating on fluid iron the coal consumed in melting the cold pigs—amounting to one-third of the entire consumption—may be saved; and the certainty obtained that all the iron under operation is perfectly fused before the boiling commences, thereby ensuring a greater uniformity in the quality. Yet, notwithstanding the acknowledged superiority of the boiling process in direct connection with the blast furnace, and the period which has elapsed since the adoption of this mode of operating, the number of furnaces working in this manner is not large. The necessity of reconstructing and bringing the forge inconveniently close to the blast furnace, is a great objection to its extensive use in existing works; while in the erection of new, the contracted space permitted for carrying on the operations of the blast furnace is a disadvantage, and the huddling together of the boiling furnaces that they may be near the fall, operates against the success of this mode of working in close weather. A puddling forge cannot be too open in summer: suspension of operations through exhaustion, produced by the heat evolved by the blast and adjacent boiling furnaces, is a common occurrence in these forges, and exists to a great or lesser extent in the others. In numerous continental and American forges there occur periodical suspensions of operations, caused by the excessively high temperature of the surrounding atmosphere, and even in this country it requires a considerable period to be thoroughly acclimatized to the ordinary temperature of the forge and mill.

A species of double furnace is used in several works, with a marked improvement in the yield of coal. The furnace is provi-

ded with a fire grate of larger dimensions, and the body is wider than the body of a single furnace; a working door is made at each side, and two puddlers operate at the same furnace. Twice the usual quantity of crude iron is charged; in other respects the operation is conducted as in single furnaces. It is difficult, however, to get the puddlers to work well to time; unless this is accomplished, no advantage is realized over the single furnaces. The two men must bring their heats to the respective stages simultaneously, in order to render these furnaces profitable; if one is kept waiting for ever so short a period by the other, the loss in iron more than balances the reduced consumption of coal. This difficulty of obtaining men who will work in concert, has operated against the general use of double furnaces; were it not for this circumstance they would entirely supersede the single furnace. Combined with the running-in process the consumption of fuel is under the one-half of the quantity demanded with single furnaces working cold iron.

PUDDLING REFINED PLATE METAL.

The puddling furnace differs but very slightly from the boiling; with a few alterations in the interior, principally confined to lowering the flue bridge, which in the puddling furnace is seldom more than 6 inches high, and raising the bottom to within 8 inches of the door, the boiling furnace, as described, is equally well suited for puddling.

The process differs from the boiling in the absence of that swelling and violent agitation of the fluid iron. The general charge is $4\frac{3}{4}$ cwts. of broken refined metal to a heat. In boiling crude iron it is usual to withdraw the finished balls before charging a fresh heat; but in puddling, the refined metal is charged through the small door next the flue, at the period when the portion under operation has arrived at the pasty condition, and when the reduction of temperature consequent on the introduction of a body of cold metal, has no sensible retarding effect on the progress of the operation. The metal therefore is exposed to the heat of the furnace for a period of 15 to 18 minutes before the withdrawal of the previous heat, and when drawn forward into the body of the furnace, has been elevated to a dull red heat. The damper being opened a sharp heat is obtained, and in from 10 to 12 minutes the metal is melted, and the process of puddling it commences. Containing an inferior quantity of metalloids and carbon in alloy, the refined iron is converted with comparative facility. The same incessant raking motion by the puddler, relieved occasionally by the helper, is practised as in working crude iron, followed by the separation in a great measure of the alloys from the iron; finally it is brought to a similar pasty condition, and balled up.

From the time of charging to the extraction of the last ball, the puddling process occupies about 1 hour and 20 minutes; but as it is charged 15 minutes before the extraction of the previous charge, the time actually occupied in the working of each heat is 1 hour and 5 minutes. With inferior workmen the process will average 1 hour and 35 minutes.

The time and labor expended in converting the superior qualities of iron is greater than that required with the inferior kinds. The gray varieties will require 20 to 25 minutes additional in coming round to nature, as the working puddler terms the point, from whence the balling-up stage may be said to commence. The cause of this longer time appears to arise from the larger quantity of carbon in the metal, its disengagement requiring longer exposure to the oxygen of the passing current of heat, and repeated manipulations. The honeycomb structure of high-blown metal facilitates the operation, inasmuch as it augments the surface exposed to the high temperature of the furnace, and diminishes the time necessary for the oxidation of the carbon, and alloyed earthy matters.

In the conversion of iron from carbonaceous ores smelted in the manner now practised at Scotch works, the labor is very severe. Fusing at a low temperature, and containing the largest percentage of carbon, it is brought to the malleable state with the greatest difficulty. The extremely fluid character of these irons is caused by the volume of carbon combined, and it is essentially necessary that this be oxidized before malleablization commences; the absence of a good cinder for the protection of the iron, and the frequent presence of sulphur lengthen the process, augment the waste, and deteriorate the quality.

The produce and general quality of several irons are frequently improved by the addition, during the process of conversion into malleable bars, of a mixture composed of ground magnetic oxide, or a rich hematite, caustic lime, and a minimum dose of the black oxide of manganese; the quantity may amount to 5 or 6 per cent., by weight, of the charge. The operations are facilitated and the malleablization greatly improved by their employment, which we attribute to the oxygen of the ore and the caustic lime uniting with the carbon and sulphur of the metal, leaving it in a state of greater purity.

The presence of sulphur and several metals, including brass, copper, lead, and zinc, retards the puddling process. If existing in considerable quantity, the iron cannot be brought to the pasty condition necessary for balling-up, all the efforts of the puddler are thrown away, and the heat is eventually raked out in granular masses. Crude iron rarely contains either of these metals in injurious quantities, but where they obtain admission, the agglutinous character of the mass is destroyed, and the farther conversion of the cast into malleable iron consequently prevented.

Puddling hot iron direct from the refinery has been practised, but it is doubtful if the limited advantages attending this mode of working can ever result in its extensive adoption. The crude iron after refinement is run into a puddling furnace of the ordinary construction and converted in the usual manner. The invention is a very old one, having been first tried nearly half a century ago. A due separation of the metal from the cinder produced during the refining process, appears to be the principal difficulty in this mode of working. In the common refinery the metal and cinder escape together from the hearth, but when connected to the puddling furnaces the metal only is permitted to enter, the cinder being obtained at a separate running. Close attention therefore is required to be paid to their separation; for, if cinder enters the furnace along with the metal, the conversion of the charge into malleable iron is rendered more difficult, and the quality debased, while the escape of metal along with the cinder results in a direct loss.

Puddling with steam has been experimentally tried several times within the last few years. The original experiments were made at the Dowlais works, where the plan was in operation at several furnaces for some months. The invention was considered at the time to be a decided improvement; producing a superior quality and a larger quantity weekly. The steam was brought down to the surface of the iron by a row of vertical telescopic pipes, passing through the roof of the furnace; their depression and elevation being under the control of the puddler. On the withdrawal of the heat the steam was directed on the liquid cinder, until it was cooled down to a pasty consistence, when it was raked up against the back, sides, and bridge of the furnace, to fill up any cavity that may have been burned during the working of the heat. This operation on the cinders so that they could be used instead of clay or limestone, was deemed of great importance to the quality of the iron—a less quantity of earthy matter combining with it during the puddling. After an extensive trial however, it was discovered that the advantages realized in the large way were not commensurate with the expenses attending the application and maintenance of the steam apparatus. As the value of the invention was tested in furnaces before the patent was secured, its subsequent abandonment may seem inexplicable.

In the first experiments made with it, the value of the discovery was considered as fully established by the large produce obtained from a furnace working on this plan, amounting to 28 tons weekly, the improvement discerned in the quality, and the substitution of the cinder treated with steam for the clay and limestone previously used for repairing. But when applied to a considerable number of furnaces, the average weekly produce was not greatly in excess of that obtained before its application, the mean quality was not superior, while the substitution of the

steamed cinder for other materials could not always be depended on. Having witnessed the whole of the experiments, we are of opinion, (and the apparent success attending a modification of the plan in some recent experiments does not alter that opinion,) that the improvement ascribed to the use of the steam was due entirely to the superior abilities of the workmen at the furnaces selected for trial. In this we are borne out by the observations of subsequent years. We do not consider the success attending any mere experiment of a few weeks' duration, in an operation such as puddling, as being trustworthy evidence of the value of an invention. There are workmen, who, with certain qualities of iron, will bring out nearly the weight charged, and obtain from a furnace 28 or 30 tons, where others are working with a loss of 1½ cwts. to the ton, and unable to make 20 tons of inferior bars weekly. Hence, in experiments requiring manual labor for their successful performance, we are disposed to make from published reports large deductions for the superior skill of the workmen selected.

A steaming apparatus combined with a blast has been experimentally tried; and the more rapid decarbonation of the metal has been attempted by the employment of a heated blast, directed in numerous jets to the surface of the iron, but eventually abandoned as causing an excessive waste, by the increased oxidation of the iron.

In the early puddling furnaces the body forward of the ash pit was filled nearly to the level of the intended bottom with cinder or other material; above this a sand bottom was made on which the puddling was conducted. The sand bottom however gave way to the iron bottoms now universally adopted in preference to all others. For boldness and originality, the idea of using a thin plate of cast iron as a bottom to a furnace constructed expressly for melting crude iron has not been equalled; and without this invention the puddling process could not have obtained its present high state. Next to the invention of puddling we look on the iron puddling bottom as the greatest improvement effected in the operation of converting crude into malleable iron.

While sand bottoms were in use the yield was extravagantly high; the consumption of coal in the furnace was great; and the resulting bar iron absorbing a portion of the siliceous bottom was inferior in quality. This inferiority would have been more apparent but for the ponderous forge hammers generally employed at that period; a portion of the cinder was expelled during the violent hammering to which the blooms were subjected; but, as a quantity of the metal also was detached during this process, the subsequent improvement was not effected without great waste of the iron. Formerly, the ton of puddle bars was made with a consumption of 30 cwts., sometimes so high as 36 cwts. of refined metal; with the present furnaces it is accomplished with about 21

cwts., and, as there has been no sensible reduction for the last 25 years, we must consider the substitution of iron for sand bottoms as having principally effected this great improvement in the metal yield.

The portions of the furnace exposed to the intense heat and action of the fluid metal unprotected by cinder are rapidly burnt away. For repairing, fire clay is largely used in several Welsh works, while in others calcined forge cinders are successfully adopted. The cinder, when the calcination has been carried so far as to convert it into a refractory silicate of iron, is undoubtedly the best material. From experiments, however, it does not appear that all forge cinders are equally applicable to this purpose; varieties containing a large quantity of iron and sparing quantities of silica and alumina cannot be used with the success attending leaner cinders. Limestone is frequently used in boiling furnaces in preference to any other material.

To increase the durability of the brick-work, hollow metal troughs protected in front by a thin facing of brick, have been used with partial success; the work being kept comparatively cool by a current of air maintained in rapid circulation. The plan has been several years in operation at the Dowlais works, and is largely adopted in all the iron-making districts. The principle has been carried so far as to substitute water for air, by lining the sides and bridge of the furnace with hollow castings, connected with each other, and containing water in circulation; greater durability was ensured, but the difficulties in the way of applying this successfully were found too great in practice. The numerous contractions in the pipes connecting the various pieces, and the liability to leakage at the joints, rendered the plan an extremely dangerous one. In an experimental furnace erected with water boshes a temporary stoppage of the water was, on its re-admission, followed by a severe explosion, carrying away the roof and entirely demolishing the furnace. To remove the danger from stoppages in the branch pipes, the entire furnace was surrounded with a water tube cast fast, and forming a flanch to the bottom plate; but in the course of working it was discovered, that, through the unequal expansion and contraction of the metal, the liability to accident was still most imminent. The intense heat which is communicated to the metal, if unprotected by the current of water for a few minutes only, results in the instantaneous production of volumes of steam greater than the exit pipe can convey away in the limited time.

It is, however, a matter for serious consideration, whether the employment of air or water boshes is attended with any real advantage to the manufacturer, granting that no difficulty occurs in their application. Contrivances of this kind are usually proposed on the score of greater economy in some material. In the case of the boiling and puddling furnaces they effect a saving in the wear

of the brickwork, rendering the interior of the furnace more durable, and enabling it to be worked with less repair—by repair we allude to such as is effected by the puddler with clay, calcined cinder, or other material, all of which are more or less injurious to the quality of the bar iron produced. The direct saving in brickwork may be ascertained in practice; the value of the improvement in quality cannot be easily ascertained—against these advantages there must be placed the absorption of heat by the boshes.

While on this subject we may remark, that, in the majority of patents connected with the working of iron, an utter ignorance of the simplest principles of the manufacture may be seen. It is not confined to the theoretical inventor alone; the practical engineer often may be seen securing to himself the merits of an invention, which, on investigation, proves worse than useless. That it is the case with water boshes, and numerous other cooling contrivances employed in the manufacture, is very evident, if a brief consideration be given to their action. In a puddling or other furnace a high temperature is required to be generated quickly, and maintained with the least consumption of coal. The arched and deflected form of the roof, by reverberating the heat back on the bottom favors the attainment of these objects; an effect, still further heightened by the reflective power of the vitrious glaze, adhering to the brickwork. The escape of caloric otherwise than in contact with the metal under operation, it is desirable to prevent, by using in the construction of the interior lining as perfect a non-conductor and non-absorbent of heat as may be attainable for the purpose. The principle to be observed being the retention and concentration of the heat, that a maximum produce of iron may be obtained with the consumption of a given weight of coal. Fire brick is the only material obtainable in sufficient quantity at a cheap rate; where a thickness of 8 or 9 inches is employed, the loss by conduction is not great. Hence, the furnaces are built and roofed with fire brick, which generally lasts from 3 to 4 months in a workable condition. But in the substitution of iron water boshes we see the opposite principle enforced. The temperature of the walls is lowered by the employment of a ready conductor and absorbent of heat, and, as the current of air cannot absorb the caloric at the rate which the iron conducts it, the more rapid absorption by a current of water has been adopted. The principle of husbanding the heat evolved by the combustion of the fuel is altogether abandoned, and facilities are afforded for its escape. In all estimates, then, of the advantages derivable from water boshes the loss incurred by the escape of caloric in the water must be taken into consideration as well as the loss of metal displayed by the inferior yields. In the case of a blast furnace we have shown that the heat absorbed and carried away in the water requires an expenditure of 7 tons of

coal weekly for its production. By measuring the quantity of water, and taking its temperature previous to entering, and after its escape from the boshes of the puddling furnace, the quantity of coal consumed in elevating it to the higher temperature may readily be ascertained.

The case of a furnace built entirely on this retrograde principle illustrates in a very forcible manner the impolicy of employing materials of high conducting and absorbing powers. The portions of the furnace usually constructed of brick, including the roof, may be formed of wrought, or cast iron plates, having water in contact; but with the conducting power of the iron, and the absorbent power of the water, it would be utterly impossible to attain, under any circumstances, a temperature sufficient for the fusion of crude iron. If then a portion, however small, of the interior is thus formed by iron maintained at a low temperature by the contact of water, to a precisely similar extent will the efficiency of the heat evolved by the fuel be impaired; and consequent on this reduction in the working temperature of the interior, the yield and produce of iron are similarly affected.

YIELDS IN THE BOILING AND PUDDLING PROCESSES.

The consumption of iron to produce one ton of puddle bars in the boiling process varies with the quality of the pigs, and to a minor degree on the quality of the coal. The yield of good forge pigs smelted from a high burden we find to average 21¾ cwts., with a forge of puddlers of average abilities; with less able men in other forges, working under precisely similar conditions, the yield has been 22 cwts., 3 qrs., 14 lbs. If the conditions are very favorable, and the puddler skilful, the ton of bars can be produced with 21¼ cwts. pigs.

The yield of bars from crude iron, smelted from carbonaceous ores, is probably the worst of any converted. From the working of the large forges at the Monkland and Dandyvan works, we find that the consumption of pigs in these establishments, in the boiling furnaces, averages 23 cwts., 3 qrs., 19 lbs. per ton of puddle bars.

The ton of puddle bars may be produced by the puddling process with a consumption of 21¼ cwts. of refined metal. This is the average consumption in a forge of 16 furnaces, worked by men of fair average abilities. It can, all circumstances being favorable, be made with 20¾ cwts. of metal; but, taking the average of 85 furnaces for 22 years' working, we find the yield to average 21 cwts., 1 qr., 20 lbs. during that period.

The consumption of coal is subject to nearly similar variation. With a bituminous, yielding much flame, and superior workmen, it will average 14 cwts. per ton of boiled-iron bars. With a less inflammable coal it will rise to 18; and with the coals mined on the edge of the anthracite basin, 22 cwts. is near the average.

The weekly consumption is nearly the same with the different varieties of iron; hence, with those most difficult of conversion, the yield per ton is augmented in an inverse ratio to the reduced make. Inferior puddlers will burn from 4 to 5 cwts. per ton more than able men. The double boiling furnace effects a considerable saving of fuel if successfully managed; the yield being fully one-fourth less.

The consumption in puddling refined metal is smaller than with pigs; with coal of good quality, and suitable for reverberatory furnaces, the ton of puddle bars is produced with a consumption of 10 cwts.; proceeding, however, to the semi-anthracite district it is 17 and 18 cwts. per ton.

The more perfect combustion of the coal, resulting in a slight diminution in the quantity used, has been produced by introducing into the fire-place, above the fuel, atmospheric air for the ignition of the gaseous products. The invention requires closed ash-pits for its successful application; the air supplied to the coal above and below the bars being heated in flues underneath and at the sides of the furnace. The commingling of the gases and air is effected by a perforated divisional bridge, through which the heat passes to the body of the furnace. Irons melting at a low heat have been worked with a considerable saving of fuel; but with the harder kinds the obstruction to the draught, caused by the bridge, renders the furnace less manageable, and the loss in the yield of iron is of far greater importance than the saving of coal.

The horizontal area of the chimney flue at the junction of the stack with the furnace, is mainly dependent on the character of the coal. With the highly bituminous varieties, swelling considerably during their combustion, and, by lying close in the grate, obstructing the draught, the flue in this place, technically termed by furnace builders the "take-up," is made about 18 inches square, for grates measuring 2 feet 8 inches by 3 feet 9 inches, or 32 inches of flue area for each superficial foot of grate. At the Hirwain works, where the coal is of a semi-anthracite character, producing little flame, and increasing very slightly in bulk during combustion, the take-up is 17 by 10 inches, for grates 2 feet 4 inches by 3 feet 5 inches—equal to 21 inches of flue area for each foot of grate.

The area of the take-up is regulated also by the skill of the puddler; a good workman will prefer a contracted flue, but an inferior hand desires a larger area. Less skilful in the manipulation of the iron, the enlarged area affords greater control over the draught at the expense of the iron under operation, a portion of which is oxidized and lost. The maintenance of the take-up unaltered is considered of the first importance with puddlers, and where it is constructed of fire brick, the enlargement after a week's work requires that it be taken down and renewed. Sandstone,

from its greater durability, has been adopted at some works. If not reconstructed of the original size, the metal yields become worse as the area increases, and with a forge of good workmen, we find that as the time for repairing approaches the mean yield of iron per ton of bars is augmented.

The area of the fire grate is also dependent in a great measure on the quality of the coal. At the Hirwain forges an area of 8 feet is adopted as sufficient with their coal; proceeding to the other forges belonging to the same firm, and working iron from the same blast furnaces, we find the grates averaging 10 feet in area. From the very different qualities of the coals, however, the lesser area of grate at Hirwain burns a greater quantity than the large grates at the Forest works; although the area of the take-up in the latter furnace is nearly twice the area of that in the former.

MAKE OF PUDDLING AND BOILING FURNACES.

The make of a boiling furnace is dependent on the skill of the puddler, quality of iron operated on, and the general character of the coal. Where these are favorable the weekly make will not fall short of 21 tons; the average may be estimated at 18 tons. This is greatly above the produce in some districts. The Staffordshire furnaces, for example, do not usually average more than 10 tons weekly. The lesser make in this district may be explained by the shorter period they are under work, and the slower rate of working practised by the puddlers—resulting, however, in the production of a superior quality. In the Welsh district, with an abundant supply of the raw material, iron and coal, the furnaces are under work 140 hours weekly; the only stoppage being 4 hours Saturday evening, and the whole of Sunday. In Staffordshire, the furnaces are lit on Monday evening, and let out early on Saturday; the working period seldom exceeds 100 hours in the week. Through keeping the furnaces longer at work each week, the Welsh ironmasters are enabled to turn out a comparatively large quantity of iron with a limited number of furnaces. The yield of metal is believed to be improved, while there can be no question but that the yield of coal is considerably diminished; a certain quantity being expended weekly in elevating the interior to the working temperature, the consumption for each ton of iron will be in an inverse ratio to the weekly produce.

The make of the double boiling furnace will average 36 tons weekly. Working on hot iron from the blast furnace, the make is so high as 46 tons. Similar furnaces at the Chillington forges, Staffordshire, produce about 28 tons weekly. The make of puddling furnaces working on all refined plate metal depends very much on the skill of the puddler. With first-rate workmen, and iron and coal of favorable quality, the produce will reach 28 tons;

with inferior hands the make will be about 21 tons. Taking the average of 18 years' puddling, the make of puddle bars from 5 forges has been 23 tons per week for each furnace at work.

FORGE HAMMERS AND SQUEEZERS.

The puddle balls are by the helper puddler delivered to the "shingler" for shaping into blooms, preparatory to rolling between the puddling rolls.

Formerly, the operation of blooming was universally performed with heavy hammers, which consolidated the balls by repeated blows and expelled much of the cinder. During the severe hammering to which it was subjected the bloom was placed endwise, receiving blows in that direction in order to "upset it," or condense the particles of metal longitudinally. It is generally admitted that for quality no substitute has hitherto been discovered for the hammering. In the yield, the principal consideration in the manufacture of much of the bar iron of the present day, the modern reciprocating squeezer is certainly superior.

The substructure of a forge hammer usually consists of a solid timber bedding containing from 1000 to 1500 cubic feet of oak, capped by a cast iron bed plate measuring about 24 feet by 7 feet, and weighing from 10 to 12 tons. On the bed plate within strong jaws, two standards weighing about 3 tons for carrying the helve are secured, and a third, for carrying the cam-ring shaft of nearly similar weight. The helve is T shaped in its plan view, and measures about 8 feet long, 6 feet wide, at the centre of vibration, 12 inches wide, and 2 feet deep in the middle, and weighs from 5 to 7 tons. At one end it has a recess for receiving the hammer face, which measures 18 inches square at the lower side. On the bed plate, under the centre of the hammer face, is the anvil block, weighing from 5 to 6 tons, having an anvil face on its upper side similar to the hammer face. The helve and its hammer face are lifted by a revolving cam-ring 5 feet in diameter, having projecting cam-pieces on its circumference, which catch in the point of the helve, lift it up, and passing farther around, permit it to fall on the bloom under operation.

The strength of these ponderous hammers, and the weight of the blows given may be estimated by the weight of the castings used in the construction of one of medium size. Bed, 11 tons; helve standards, including brasses, 3 tons; helve, 5½ tons; hammer face, 15 cwts.; anvil block, 5½ tons; anvil face, 16 cwts.; standards under cam-ring shaft, 2½ tons; cam-ring shaft, 12 inch bearings 2 feet 4 inches diameter in the middle, 7 tons; cam-ring, 4¼ tons; 4 cams, 24 cwts.: total 41½ tons.

When not in work the helve is propped up by an iron bar, which fits into recesses cast in the anvil block and helve for that purpose. The puddle ball having been placed on the anvil face,

the helve is lifted off the support by the insertion of a thin block under its point; the prop withdrawn, the helve descends on the ball to be again lifted by the passing of the succeeding projecting cam. The height of the lift depends on the position of the helve and cam-ring; provision is made in the standards under the former, for any alteration that may be deemed necessary; for a hammer of the dimensions described, and delineated in Plate 11, it averages 16 inches. The gearing on the cam-ring shaft in connection with the engine, or other prime mover, is proportioned to 18 or 19 revolutions of the cam-ring per minute; consequently with four cams in the ring the number of blows per minute ranges from 72 to 76. The puddle balls receive from 15 to 25 blows, occupying from 18 to 25 seconds of time, to convert them into blooms.

The squeezer has almost entirely supplanted the hammer in the forge; its first cost is not half so much, the cost of maintenance is diminished in a similar ratio, and if the quality of the iron treated is not improved, the quantity produced is in its favor. The squeezers commonly employed have a reciprocating motion; and are distinguished as single and double ended. The single have but one anvil and one hammer, the double have two hammers and two anvils.

For a double-ended squeezer, similar to the one represented in Plate 10, the cast iron bed plate is laid longitudinally on two balks of timber; it measures about 20 by 5 feet, and weighs 6 tons. On one end, strong standards fitted with bearing brasses are securely fixed to it, to carry the double crank employed; and near the centre two other standards are firmly secured to the plate to carry the squeezer arm, which consists of a V shaped lever, moving with a centre gudgeon; one of its ends being connected by a sweep rod to the crank. Recesses are cast in the lever for the reception of hammer faces, 3 feet by 18 inches wide, and 5 inches thick; on the bed plate below, a strong horizontal framework carries the two anvil faces, each measuring 6 feet by 18 inches, by 7 inches thick. When mounted, and in equilibrium, the inside end of each hammer face is 5 inches, and the outer end 16 inches from the anvil face. If the crank has a 16 inch stroke these dimensions are diminished to 4 and 11 inches at the bottom centre, and increased to 6 and 21 inches at the top centre.

The weight of the various castings composing the double-ended squeezer described may be stated as follows: bedding, 6 tons; crank shaft standards, 2½ tons; crank, 12 cwts.; standard under anvils, 4 tons; centre standards, 2 tons 16 cwts.; squeezer arm, 3¼ tons; anvils, 36 cwts.; hammers, 14 cwts.: total 21 tons, 13 cwts.

In squeezing, the puddle ball is delivered by the helper puddler to the shingler, who moves it forward on the anvil until it arrives in contact with the hammer face; at each stroke of the squeezer the ball is flattened by the pressure, and a portion of

the cinder expelled; during the upstroke it is turned over by the shingler towards the fulcrum of the arm, where, after receiving from 15 to 20 strokes in its progress, it is reduced to a bloom about 5 inches diameter, and 18 inches long. The upsetting is performed at the extreme end of the squeezer, where its elevation above the anvil gives sufficient space for the bloom to be pressed endwise.

The squeezer crank revolves from 45 to 80 times per minute, according to the speed at which the rolls are set; the latter is a fast speed, and 55 to 60 is more advantageous. The time occupied in squeezing each ball averages 25 seconds, where the crank revolves 60 times per minute, giving 25 blows altogether to each bloom.

The hammering and squeezing processes differ, inasmuch, that, in the former the bloom is produced by the impact of the descending hammer, and in the latter by direct pressure. In erecting a hammer the chief requisites are, a foundation capable of withstanding the concussion, and machinery capable of lifting, and supporting the helve at the rapid rate of working practised. For this purpose the castings are made very heavy, and weigh, as we have shown, above 40 tons, of which nearly 19 tons is in rapid, though irregular motion. In the construction of the squeezer the tensile strength of the cast and wrought iron is severely tested. The crank and centre standards, sweep-rod, and squeezer arm are subject to enormous strain, and require to be made proportionately strong. From the experience obtained in the working of 9 puddling forges, we learn, that the aggregate sectional area of the crank standards in their weakest part requires to be 136 inches; the centre standards 212 inches, and the wrought straps on the sweep rod 12 inches.

With the weights and proportions given the duration of the respective moving parts will be nearly as follows, in a forge working 16 furnaces;—squeezer arm, 10 months; anvils, 6 months; hammers, 11 months; cranks, 3 months; brasses to cranks, 3 weeks. The duration of the anvils and hammers may be largely increased by casting in them a small wrought pipe, bent in a serpentine form, and kept cool by a current of water in circulation, thereby preventing an undue temperature, and the adhesion of the cinders. The inlet and outlet pipes of the hammer are brought over the centre gudgeon where the vibration is least, and connected by flexible tubes to other pipes. By maintaining a currento f water in circulation the hammer and anvil will work twice the usual quantity of iron before renewal.

Motion is usually communicated to the squeezer by coupling the crank direct to the end of the bottom roughing roll of the puddling train; in a few works, shafting independent of the rolls is employed, and the squeezer driven at a reduced speed; in other works a separate engine is employed to drive it. With separate

shafting the strain is taken off the rolls, but the greater number of bearings in motion, and the additional spur gearing increase the resistance to the working of the forge; and probably balance any advantage attending a separate movement.

The connection of the squeezer crank with the end of the roll, should at all times be made with a connecting spindle of such length as circumstances will allow. Connecting direct to the end is bad, though generally adopted; the lifting of the squeezer crank causes the roughing rolls to wear unequally, and throws an unnecessary strain on the necks. By employing an intervening spindle this is avoided, and the durability of the rolls and crank increased. Greater facilities are afforded for changing the rolls, and the stand for the rougher, generally intensely hot, is made more bearable.

Various modifications of, and substitutes for the common lever squeezer have been devised and used to a limited extent. The first on the list was an American invention. It consisted of a circular cast iron well, containing an interior revolving cylinder of similar depth placed eccentrically; the least distance between the two was equal to the diameter of the finished bloom, while at the widest the breadth was equal to the diameter of the largest puddle ball. Motion having been communicated to the inner cylinder by strong bevil gearing in communication with the engine, the ball is placed in the machine; the revolving cylinder armed with numerous short teeth on its circumference, seizes it, and during its revolution, by a combined squeezing and rolling motion, the ball is reduced to a bloom of the desired dimensions, and delivered at the opposite side of the rougher.

The machine altogether is a specimen of great ingenuity, but in practice the bevil gearing and the liability to derangement are great drawbacks to its employment; besides which, no effectual means are provided for the upsetting of the bloom,—an operation which cannot be dispensed with if the quality is to remain unimpaired.

An apparatus on a similar principle with a vertical movement is also in very limited use. The revolving cylinder is mounted on strong cast iron framing, between which a semi-cylindrical casting is fixed eccentrically to the cylinder. The conversion of the ball into a bloom is effected in a manner similar to that of its prototype, the American machine, and it possesses the same defects. In one erected at the Plymouth works the upsetting was attempted by side blocks acted on by springs; self-feeding and delivering machinery was attached, and otherwise it was probably the most complete and costly of its kind. Its working however was not satisfactory, and recourse was had to the lever machine formerly employed.

In another substitute the blooming is accomplished by passing the ball between three eccentric rolls, which, during their revolu-

tion by compression and rolling, distends it laterally to the size for the rougher. The three rolls work on bearing brasses in a strong cast-iron framing, and are coupled together by nuts and spur-gearing.

There are features common to all the substitutes yet offered for the common squeezer which have not been sufficiently considered by their inventors. Their first cost is from four to ten times as great; and the effectual upsetting of the bloom is only accomplished by using very complex machinery. This large outlay for an apparatus, which at best does no more than the simpler machine, is an important consideration with ironmasters, and sufficiently accounts for the few at work. With the greater first cost of numerous working and wearing parts, the cost of maintenance is increased in nearly the same ratio. Generally speaking too, the improved squeezers are not erected without numerous portions having been turned and fitted; in the event of breakage considerable delay must necessarily occur in the replacement of such parts. The common squeezer, turning the crank excepted, has no fitting work whatever in its construction, and in the event of a piece breaking, may be got to work again in two or three hours at the outside.

In one respect, however, the improved sqeezers certainly are superior. With the lever machine, if the metal in the ball appears to be insufficiently worked by the puddler, the shingler can reject it, or let it stand a few seconds before shingling. In the revolving squeezer no discrimination can be made, and whatever be the condition of the ball, it enters and is subjected to the rolling and squeezing movement. The properly wrought iron passes through safely, but the labor of the inferior hand, too friable to stand under the dragging motion, is torn to pieces. The apparatus, therefore, to a certain extent is a check on the puddling, for unless the iron is wrought with great care, the yield is very bad. When the entire forge is composed of good hands, and the quality is desired to be superior, the work produced will be equal, though not superior to that produced with like care from the common squeezer; but with a forge of mixed hands, while the quality will be largely in favor, the yield will be against the improved squeezers. The proprietors of these state that they effect a great improvement in the quality of the iron over that produced by the old squeezer. This is very far from correct. No squeezer can improve the quality of the iron. The quality is dependent on that of the crude iron used, the substances subsequently incorporated with it, and the ability of the puddler. If the crude iron is bad and the puddler an indifferent hand, no squeezer, or other machine ever invented, can improve the quality of his work.

(To be continued.)

Art. II.—EXPERIENCE OF THE GOLD MINES OF CALIFORNIA.

PITTSBURG MINE, NEAR NEVADA, NEVADA COUNTY.

This mine was located in the month of September, 1850, by the present proprietor, R. S. Whigham. After its location and during the following year, the engine and appurtenances for reduction were manufactured for this mine in Pittsburg, and shipped in November of the same year.

On the 20th of June, 1852, the engines and batteries were erected and ready for running, and during that month went into operation.

During the erection of the mill, house and machinery, a shaft had been sunk on the vein to the depth of seven fathoms, and an adit driven two hundred and sixty feet, which cut the lode at this point, at right angles to its strike; a level was then driven northward for two hundred and sixty feet, which gave the same length of backs on the lode ready for excavation.

In addition to the above, a train-road was laid from the mouth of the adit to the mill, a distance of five hundred and sixty feet.

From the month of June, 1852, to the end of the year (June, 1853), the mine was in active and constant operation, obtaining the ore exclusively from the Pittsburg lode, the yield of which varied from ten to fifty dollars per ton, the average for the year being twenty-four dollars and ninety cents per ton. At this time the mine was leased to the West Mariposa Quartz Mining Company for a period of two years, their lease expiring on the 25th of June, 1855.

The operations of this company were under the principal superintendence of S. M. Murry, the English company's agent, who, with his attaches, commenced operations in their characteristic style, and closed out their labor department in 1854, with the exception of such as required the use of ink and paper only.

At the time this company took charge of the Pittsburg Mine it was well opened, and in good working condition. They had driven an adit but a short distance south of the former workings, when a *peculiar* idea seized the minds of the Directors, that the lode would run out at some future time, if they persisted in following its legitimate and well-defined course. Accordingly, an order was issued to cease operations *on the lode*, and to drive in a direction at nearly right angles to the strike of the vein, that they might strike it again at a point some distance ahead, where the merest novice would see that such an event would be a total impossibility, from the line of cutting adopted, and the distinct, well marked course of the river.

At the point of the *new* workings they left a lode, whose power was sixteen inches, and had increased nearly four inches in twen-

ty-seven feet on the line of strike; and after driving as directly as possible to the distance of ninety-three feet away from the vein, they arrived at the sage conclusion that the lode had run out, and reported accordingly to the parties by whom they were employed.

In this case we have one of those *strange* feats of nature, that are so remarkably rare in their occurrence that they are regarded as phenomena of great interest, and find a place in annals of science, to be handed down to posterity.

This was no other than an optical delusion on the one hand and an extraordinary pre-vision on the other. For in the one case their optical powers would not permit them to discern an eighteen-inch lode two hundred and sixty feet in length, over which they were obliged to pass constantly in and out of the mine, and on the other hand their mental powers were of sufficient strength to descry a lode one hundred feet beneath the surface, and ninety-three feet from any point that one could possibly exist.

The result of these operations was, that they had the effect of nearly ruining one of the most valuable mines in the State, and at the expense of about $20,000 for their stockholders at home. This magnificent failure (to call it no worse name,) of the foreign company, soon made the Pittsburg Mine a by-word rather than anything else, and injured that property to an extent, that had it been put under the hammer it is doubtful if the whole concern would have brought the first cost of the engine, and a more sad mistake was never made than the lease of this property under the circumstances.

There is no censure that is too severe for conduct like the above. On the 25th of June, 1855, the proprietors again came in possession of the property by the expiration of the lease, and at the time I visited the mine they had repaired their machinery, and had commenced the reduction of ores again from the mine. The period in which ore had been reduced from Pittsburg Hill was about two months, and at no time had it yielded a less sum than twelve dollars per ton, and ranging from that to forty-six dollars per ton, thus showing that the mine was worked with its former success.

How is it that men unskilled in metallurgy and mining can succeed in this manner, and such universal defeat mark the progress of men making high pretensions in those departments, who have been, and still are, engaged in the same branches of industry in our midst? I am not disposed to reproach or criminate where it is not justly due, but at the same time I cannot permit some things to pass unnoticed where a State is to be the sufferer, even though it may prejudice the private interests of friends, acquaintances or individuals.

This subject is by no means exhausted. Much more might be said than here committed, not only in relation to this, but other operations similar in character. But I have no desire to drag

personal conduct and management into a public document, it is far more fitting for a private journal.

I have thus far seen no reason to retract one syllable from the remarks that may be found on page eighty-four, Document No. Fourteen, Session of 1855, but each additional feature that presents itself relating to this subject would only place that language in a still stronger position.

The following statistics will show the operations of this mine for 1853, the full running time being nine months, the period named would constitute at that time the workings for one year.

Number of men employed, eighteen.

8 Miners, at $100	$800
4 men at Mill, $4 per day	416
1 Carman	50
1 Shaft Tender	60
1 Engineer	100
1 "	75
2 Battery Tenders, at $75	150
3 cords wood, per day	234
Incidentals	208
Total monthly expenses	$2,093
Engine and Mill	$30,000
4 Shafts	1,344
1 Adit	2,080
1 Level	8,120
1 Train Way	6,720
Total dead work	$43,264

Aggregate ore reduced, 4,680 tons. Average yield per ton $24 90.

Aggregate monthly expenses	$18,937
" receipts	112,320
Balance in favor	50,000

RECAPITULATION.

	Fathoms.
4 Shafts	7
	Feet.
1 Adit	260
1 Level	260
1 Train Road	560

Working three fathoms below water line.

This brief history and statistical matter of those mines, from which we have the returns of their operations for the periods given, is sufficient to show the healthy and stable condition of this branch of employment, and their yield is fully sufficient to warrant all that I have said in former reports relating to their intrinsic value. The rapid increase in the number of mines, during the past three years, may also be taken as an evidence of success; more particularly so when it is known that this species of property does not appear as stocks either in foreign or domestic markets.

Their rise and advancement, therefore, cannot be attributed to speculation, or jobbing, at home more particularly, for here this property has not, as yet, divested itself of those opprobriums that unprincipled speculators (who were more willing to earn their living by any other means than legitimate labor) on the one hand, and the inconsiderate manner of investment and working on the other, attached themselves, like deadly parasites, during the days of its comparative infancy. But a kind Providence interposed, and soon produced a *finale* to their *brilliant* career.

Unsupported by any of those extraneous influences usually brought to the support of faltering mining property, they have lived beyond the possible reach of further injury from the causes that have hung with so heavy a weight upon the reputation and integrity of gold mining in California. It would be interesting to review their past history in full, did time permit, for each mine would furnish a goodly amount of valuable instruction of itself; but, as a condensed view will serve our purpose equally well, and at the same time convey a clear idea of their advancement and progress, this course will be pursued. I will thus state the number of mines that could be considered in full operation from 1852, to the close of 1855, a period of three years, the figures being the aggregate at the end of each year.

In the beginning of 1852, the number of mines that continued to the close of that year was fourteen. At the close of 1853, the number had increased to thirty-nine. At the end of 1854, their numbers amounted to fifty-one. And at the close of 1855, the total number is sixty-five.

In addition to the total for 1855, as above, there are thirteen companies opening their lodes, preparatory to the commencement of erecting reduction works and the reduction of their ores. But as no reduction works are, as yet, erected, they are not included as in actual operation.

I have pursued the uniform rule, never to consider a mine as having a legitimate existence until it has been in operation one full year in the reduction of ores. For if it can *sustain* itself during that period, and be prudently managed, it is certain to do more than this subsequently, in this State.

The strict adherence to this rule has brought us to the above result, as regards the number actually engaged, and which may be considered among the permanent things of the State. But had a departure from this rule been adopted, and every little vein on which a mere scratch had been made, recorded as a *mine* in operation, we should, if honest, have been obliged to chronicle failures equally numerous with those that occurred during the "great crash" in this business in 1852. The greater part of those failures were in mines of this character, and many of them even worse than this, viz: failures from having no lode whatever.

Such operations are not legitimate mining, and it is a harsh

rule to judge legitimate operations by. To apply such a rule would be equally consistent with the striking illustration of Mr. Everett, who, a short time since, in lecturing before a public body, elucidated the comparative value of gold and the products of agriculture, by which, through immense labor, he proved to his wondering and delighted audience, that the product of that metal from the mines of this State, for five years, amounting to nearly three hundred millions, *did not equal in value the entire products of agriculture of all the States* inhabited by our Atlantic neighbors. If their aggregate had not been sufficient to have swamped us, in this herculean estimate, he could have fallen back on the world at large, and the wonder is that he did not do so.

It was to be hoped that the day had passed by, when we were to suffer such prejudicial detraction from men of high character and education, but it seems otherwise. In years gone by, men of small capacities indulged in such material to astonish and delight. "*Former precedent*" of our capacities in the production of gold was their guide, but that pedestal has slipped from beneath their feet, and they are now silent. But the above comes from a higher source, and conveys more meaning than floats upon its surface. What heinous act have we, as a people, committed, that Atlantic *savans* should thus seize every opportunity to detract from even the *small* amount of *credit*, which, on *fitting* occasions, they are willing to acknowledge is our due. It is not enough that we send them from fifty to sixty millions per annum, for the material which each year they *force* upon our markets, and furnish large sums for many of their *internal improvements* to the prejudice of our own, but we must then be coolly told that the labor of eighty-six thousand men does not equal that of the balance of the Union. And they would thus insinuate an idea, which their tongues would parch at, did they attempt boldly to utter. I hope I may not have misconstrued the import of the remarks alluded to, but I can place no other construction upon them.

From these returns, some approximate estimate may be made of the character and importance of this branch of employment, and the position that we maintain as a mining State, compared to one of the greatest mining nations on the globe.

In carefully reviewing the operations of the English, Welsh and Irish mines, for forty-three years, and those of Cornwall and Devon, the close of 1847 presents us with some interesting facts and figures relating to the product of those mines, and by which we may form some estimate of the value of our own.

From the Welsh, Irish, and English mines, there were raised and sold in forty-three years the amount of 417,040 tons of copper ores, being the product of ninety-one mines for the above period. Upon this ore I place an average value of fourteen pounds sterling per ton, being a higher sum than would be claimed for those ores by those best acquainted with their value.

Their aggregate would therefore be equal to $29,192,800, giving an average product for each year from the ninety-one mines of $681,730 per annum.

The product of one hundred and three mines of copper in Cornwall and Devon, ending in 1847, amounted to 37,000 tons, which, at the same price as the above, gives us an aggregate of $13,076,015 at their value.

The total number of mines engaged, it will be seen, amounts to the number of one hundred and ninety-four, the aggregate product of which in value, is $42,268,815.

This shows us an average per annum, from the total number of mines, of the sum equal to $972,763.

During 1854 eleven of the gold mines of this State produced $777,790; and in 1855 eighteen mines produced the amount of $2,216,697, being an increase of $1,438,907 over that of the preceding year. The aggregate product in value from the total number of mines in two years being $3,016,951. Thus we find that the mines of copper of the United Kingdom, and amounting to one hundred and ninety-four in number, do not produce an annual aggregate in value equal to eighteen mines of gold in our own State.

RECAPITULATION OF THE PRODUCT OF ENGLISH COPPER MINES.

91 Irish, Welsh and English Mines produced in forty-three years the value of	$29,192,800
103 Mines of Cornwall and Devon, ending at same date...	13,760,015
Total	$42,952,815
Aggregate and average product per annum	$972,763

RECAPITULATION OF THE PRODUCT OF CALIFORNIA GOLD MINES.

11 Gold Mines of California produced in one year, 1854...	$777,790
18 " " " " " 1855...	2,239,161
Total	$3,016,951
Aggregate and average product per annum	$1,625,520

Prior to this time speculation has been the principal guide in the estimates of gold mining in this State, but at the present time we have something more tangible to rest upon; and it is to be hoped that hereafter those engaged in this employment will not so stubbornly withhold statistical matter, so necessary in forming opinions in regard to any branch of business whatever. We cannot establish the integrity of our mines by any other means, and so long as it is withheld, it must, and will, cast a shade of doubt on all such operations. It is a known fact, that nearly every mine in active operation in 1854 declared at the end of the year a handsome profit on investment and labor, yet it is impossible, almost, to draw any facts from the proprietors of the greater portion of them.

I have in my possession at the present moment the receipts of eight additional mines for 1855, obtained from parties indirectly interested, and on whom reliance can be placed, but with whom it would be a breach of confidence to make public the figures furnished. I have omitted their publication for this and an additional reason, viz: that the expenses of these mines for the same period are unknown. These figures would swell the amount already given for the past year to $3,641,090.

Had we the full returns of the product of the fifty-two mines that have continued in operation through the past year, it would be safe to presume that their aggregate product would fall but little short of $6,000,000.

ART. VIII.—ALUMINIUM—THE PROGRESS IN ITS MANUFACTURE.
By W. J. TAYLOR.

IMPURE aluminium may be whitened by plunging it into caustic potash or soda, washing it quickly with distilled water, plunging it again into pure nitric acid, again washing quickly and thoroughly. The surface then has the fine white color of pure aluminium, which it retains unless afterwards polished. This operation has for its object to dissolve out the metals which darken the color of aluminium by their presence.

Aluminium forms alloys with nearly all the metals, but those which it forms with silver and copper are the most interesting.

Five parts of aluminium with one hundred parts of pure silver produce an alloy almost as hard as a silver coin, which contains about one-tenth of copper, so that sufficient hardness can be given to silver, without introducing into it a poisonous or an alterable metal. It has the advantage of being worked like silver in a pure state, possessing, however, greater hardness, and being capable of a higher polish.

Ten parts of aluminium and ninety parts of copper produce an alloy of a pale gold color, possessing great hardness and considerable malleability; its hardness is greater than that of bronze, in the proportion of fifty-one to forty-nine. It can be worked when warm, with the same facility as the best soft iron.

Twenty parts of aluminium and eighty of copper, give to the alloy the color and brilliancy of fine gold, and at the same time sufficient hardness to scratch the alloy of gold employed in coin, without impairing in the slightest degree its malleability.

By an increase of the per centage of copper in alloys of aluminium, the alloy is rendered brittle, showing that the metal must be either used pure or alloyed in small quantities with the copper.

This explains the peculiar properties ascribed to it by M. Regnault, in his investigations on the physical properties of the aluminium prepared by M. Deville, exhibited at the Paris exhibition.

Numerous experiments have been made (without regard to economy of manufacture) to obtain the aluminium directly from the oxide alumina, or from the fluoride of aluminium.

But the results obtained by the use of this double chloride of aluminium and sodium, have fully demonstrated that it is the most economical mode by which to produce this metal. Theoretically it requires—

3·86 Chlorine, at 6 cents per pound, . . .	·23 16-100
1·86 Alumina, at 3 " "	·05 58-100
5·68 Carbonate of Soda, at 4 cents per pound, .	·22 72-100
Total, ...	·51 46-100

Making for the materials for manufacturing one pound of aluminium, estimated at the market prices, 51½ cents. Practically, it requires—

16 lbs. of the double chloride of aluminium and sodium, at 8 cts. per lb.,	$1 28
2½ lbs. metallic sodium, at about 25 cents per lb., ...	70
Flux and cost of reduction, ...	2 02
Total, ...	$4 00

By manufacturing on a larger scale, and by using the slag as a flux instead of employing fresh material, the lowest cost will be reduced to the following:

10 lbs. of double chloride of aluminium and sodium, at 4½ cents per lb.,	$0 45
2½ lbs. of sodium, at 14 cents per lb., ...	35
Cost of reduction, ...	20
Total, ...	$1 00

It is seen that the actual cost of one pound of aluminium, when manufactured extensively, will be about double the theoretical cost as before estimated (fifty-one cents).

For the production of aluminium are used clay, salt, sulphur, manganese, lime, and fluor spar, materials which are very abundant and cheap; all that is now required is practical experience, to reduce the price of the metal still nearer to the price of the raw materials, as has been before stated. The history of the useful arts contains numerous instances that, where skill and perfection of apparatus are required, difficulties are speedily overcome.

The density of aluminium when moulded is 2·56. The density of aluminium when rolled is 2·67. In equal weight with silver it is four times more voluminous. In equal weights with copper, bronze, brass, and German silver, it possesses from three to three and a half times greater volume. In equal volumes with the above metals and alloys, it possesses greater rigidity.

Mention has already been made of a very important property of aluminium when pure; that is to resist oxidation, a property which it possesses to a greater degree than the other metals.

Aluminium is not acted upon by nitric acid, hydrosulphuric acid, or by the organic acids; slightly by sulphuric acid. It is but little affected by fusion with sulphur; mustard is found to act upon it slightly. Its true solvent is hydrochloric acid.

When we compare it in these respects with those metals which are acted upon by most of these acids, giving salts which are more or less poisonous, the comparison is favorable to aluminium, as its salts, if formed, are innocuous.

According to M. C. Tissier, aluminium is not changed by a solution of nitrate or sulphate of copper, but it is dissolved by a solution of chloride of copper with the separation of metallic copper. It is attacked, however, by a solution of nitrate or sulphate of copper when it contains chloride of sodium, and this proves that chloride of copper is formed by the presence of the chloride of sodium. Aluminium is not attacked by an aqueous solution of alum, or by one of chloride of sodium, but a mixture of the two dissolves it with an evolution of hydrogen, and this proves that chloride of aluminium is contained in the mixture.

Wheatstone long since showed that aluminium was as strongly electro-negative as platinum. Its sonorous qualities are very great, like that of crystal. Various are the uses which can be made of the aluminium and of its alloys with silver and copper. All the purposes for which it could be advantageously employed in virtue of its peculiar properties, of not tarnishing by exposure to atmospheric agencies, and its lightness combined with its extraordinary strength, would be far too tedious to enumerate. A few instances only will suffice of its adaptability for philosophical apparatus, for all articles for table, for service and ornament, for kitchen utensils, for the works of clocks and even watches, for trappings of harness, for plate and door knobs, keys, &c. Its sonorous qualities render it valuable for making bells. In the galvano-plastic arts it replaces platinum.

Aluminium is most easily soldered with its own alloys. The alloys most convenient are those with silver, zinc, or tin, their point of fusion being below that of aluminium. The soldering may be done by means of a spirit lamp, and without any previous cleaning.

Pure aluminium can be easily distinguished from impure by its greater whiteness, its indistinct traces of crystallization; occasionally one or two well-defined hexagons can be recognized on the surface of the ingots. The impure has a bluish tint like zinc, and if the entire surface is not crystalline, the upper surface is always more so than in pure aluminium; the form of the crystals is also quite different.

In giving the theoretical proportion of material employed in

the manufacture of aluminium, the relative cheapness of its production, its properties and strength when comparing it bulk for bulk with other metals, it is desired to demonstrate its valuable properties and uses, also to guard against the fictitious reports so current of its excessive cheapness.

NOTE.—The experiment of Sir H. Davy should be mentioned in the early production of this metal; he endeavored to produce it by passing the vapor of potassium over alumina at a white heat; he obtained only small grey particles interspersed with aluminate of potash.

ART. V.—THE MANUFACTURE OF ALLOYS OR COMBINATIONS OF METALS.*

IT is curious, but nevertheless an undeniable fact, that no kind of manufacture has received less benefit from the recent progress of chemical knowledge in this country, than the fabrication of alloys. This is all the more surprising when we consider the enormous field open to inquiry, and the richness of the harvest to be there gathered. A new alloy is really a new metal given to society; and although the apathy of scientific men with respect to the subject has hitherto led to the production of very few such metals, yet more than one example may be cited where a large fortune has followed upon an invention of this kind. So completely, however, has Science closed her eyes to this uncontested arena of profitable improvement, that the very word "alloy," has received no chemical definition in the latest scientific works; and hence we are compelled to begin our present observations by defining its meaning with regard to the past, the present, and its probable future.

The origin of the word, as applied to metallic compounds, is no doubt coeval with the age of the so-called "noble" and "base" metals; a form of language naturally leading to the conclusion, that when any noble metal was mixed with a base one, its nobility was "allayed" or "alloyed," and consequently diminished. In this sense, the base metal came to be regarded as the allay or alloy, and as such is thus described by an old writer:—"Alloy is the proportion of a baser metal mixed with a finer or purer; as the quantity of copper that is mingled with gold, to make it of a due hardness, is called the alloy;" and with this meaning the word is still used by our assayers of gold and silver. But it is clear, from the very nature of the example here chosen, that no admixture of one base metal with another like itself, could generate an alloy in the opinion of writers of

* From Newton's Lond. Journ., March, 1856.

the old school; nor can we anywhere find that brass, bell-metal, &c., were called alloys, until mixed with gold or silver.

If, however, we now proceed to examine the meaning of the expression alloy, in the present day, we shall find that it extends to every admixture of two or more metals, and is, perhaps, no less absurdly diffuse than it was previously limited. On the new system, 99 parts of gold and 1 of copper is an alloy of gold; whilst 99 of copper and 1 of gold is an alloy of copper: nor is there any fixed or recognised limit at which an admixture of metals ceases to bear the name of alloy; in fact, almost every metal we now use, might, from its casual impurities, come within the boundaries of this definition. Lead with a trace of silver will thus be an alloy of lead; and iron containing a trace of manganese an alloy of iron. Such a state of things cannot fail, in the end, to produce uncertainty and confusion; therefore we propose to establish, for present purposes at least, a distinction betwixt what we shall call an alloy of metals and an admixture.

Many years ago Dr. Dalton drew attention to the fact, that many of the alloys in ordinary use, as brass, &c., were very nearly atomic compounds, or, in other words, mixtures of metals in such proportions, that one combining equivalent of the one was united with one, two, or three equivalents of the other; and this peculiarity was found to extend to what may be termed native or natural alloys. Thus brass of good quality consists of about 34 zinc and 66 copper in 100 parts; which is very nearly in the proportion of one atom of zinc to two atoms of copper: and again, the native alloy of gold and silver, called "electrum," is said, by Boussingault, to consist of two atoms of gold and one of silver. In fact, many such examples might be pointed out in support of Dalton's opinion, though it is quite certain that in this, as in many other of his assertions, he carried his views too far, and was misled by his mathematical bias. Silver and iron, for example, refuse to unite permanently, and separate on cooling; but the iron retains, in this case, a small and variable quantity of silver, whilst the silver retains a little iron: similarly lead and zinc comport themselves; and in neither instance can any reasonable grounds be found for inferring that an atomic combination has ensued. It would appear, therefore, that the union of some metals in atomic proportion can be effected, whilst with others it cannot; and hence, for the former, we propose to retain the word "alloy,"—using the expression "combination of metals" for the latter. On this basis, therefore, an alloy will mean a mixture of one or more atoms or equivalents of one metal, with one or more atoms or equivalents of another, so as to form what may be called a chemical compound; whereas a "combination of metals" will merely imply a mixture in no definite proportions, but suggesting the idea of a mechanical compound; thus, brass formed from 34 parts of zinc and 64

parts of copper, or 34 zinc and 96 copper, would be an alloy,—whilst our ordinary silver and gold coinage would be an admixture of metals.

With this preliminary definition we will now proceed to examine the few alloys in common use in the arts, or, more correctly speaking, those compounds which nearly approach the nature of alloys. In such a list we may place brass, type-metal, bell-metal, speculum-metal, pewter, Britannia-metal, and solder. The first has been already described; the second generally consists of about 5 parts of lead and 1 of antimony, which closely approaches to 3 atoms of lead and 1 of antimony. Bell-metal is composed of 4 parts of copper to 1 of tin, and may be regarded as an alloy of 7 atoms of copper to 1 of tin. Speculum-metal contains about equal quantities of copper and tin, with small and variable proportions of arsenic: it may, consequently, be looked upon as composed of 2 atoms of copper and 1 of tin. Pewter and Britannia-metal are triple compounds of tin, antimony, and lead, in which the proportions approach, for the first, an atom of each ingredient, and for the second, 3 atoms of tin, 2 of antimony, and 1 of lead. Solder is more variable than any of the others; but the best kind is made with 3 parts of lead and 1 of tin, which corresponds to about 2 atoms of lead and 1 of tin. There are other compounds which might, perhaps, have been brought within this group; but as, in reality, none even of those we have selected are, strictly speaking, alloys in our limited sense of the expression, it is useless to follow the subject further than to show, by this near approach to atomic combination, how probable it is that the same substances, fabricated with a due regard to that proportion, would possess more useful qualities, and less frequently disappoint the expectations of the artizan. Take, for example, the case of bell-metal, an article notorious for the uncertainty of its results: this compound contains, according to the caprice of its fabricator, from 12 to 22 parts of tin, with from 88 to 78 parts of copper, and a little antimony, arsenic, or even iron; if, however, it requires to be an alloy of 7 atoms of copper and 1 of tin, the proper proportions would be 79 copper and 21 tin. With facts of this kind before our eyes, it certainly does seem strange that nothing practical has arisen in this country with respect to alloys; and we cannot help thinking that amongst the other elements of a working man's education, the doctrine of definite combining proportions might very properly be included. It is, in effect, the "golden rule" of practical philosophy, and, once learned, can never be forgotten; by its unerring agency the discoverer is led on in a safe and economical path, far removed from the vicissitudes of chance and the errors of experiment. Let us imagine, for instance, that an artizan, after much labor, has ascertained that a certain mixture of two metals will answer the purpose he requires; this man must rest content; or, if he

thinks of improvement, it can only be in the hope that accident will one day furnish him with a hint; but, guided by a knowledge that substances have a tendency to form stable and uniform compounds only when they unite in atomic proportions, he would immediately examine the quantities he had found effective; and, if these approached within certain limits, he might easily make a correction, with the full assurance of a successful issue. And wherein resides the difficulty of teaching such men the simple doctrine in question? There is, in fact, but one difficulty, and that is to provide teachers. In all our systems of education the importance of imparting practical knowledge is much overlooked; and this is especially the case with the lower orders. As, however, it must be at all times more commendable to convert a workman into a philosopher than a philosopher into a workman, we trust the day is not far off in which the head and the hand of the same individual shall be able to work in unison.

Quitting the subject of alloys, the more extended question of metallic combinations presents itself; and inasmuch as that nearly the whole of the metallic articles now manufactured belong to this class, the investigation seems almost endless. When, however, we take a glance at the objects sought to be attained by these combinations, the result becomes much less formidable. With scarcely an exception, this result resolves itself into the two desiderata of increased mechanical strength and diminished destructibility from atmospheric and chemical agency. The latter is within the sphere of hourly observation, and includes the tinning of iron, brass, and copper, the zincing of iron, and the gilding and plating of many other metals, either by electricity or otherwise. The prospect of improvement in this department seems chiefly limited now to the employment of electricity through the intervention of other agents than water,—a medium evidently unfitted for the deposition of a great variety of metals, amongst which platinum, iron, nickel, zinc, chromium, and perhaps aluminium, may be mentioned. The object here will therefore consist in procuring materials of easy fusibility, capable of transmitting the electric current, and holding in solution the oxides or salts of the metals to be operated upon. For this purpose the fact discovered by Berthier may prove useful. It is that "various salts, in atomic proportion, fuse together at a much lower temperature than the more fusible of the two." Thus, an atomic mixture of carbonate of potash and carbonate of soda, fuses readily at a dull red heat. An atom of sulphate of lime, with an atom of fluoride of calcium, is still more remarkable; and innumerable instances of the same kind might be cited. Having thus obtained a suitable solvent, we may dissolve in this, at a red heat, some of the metallic substance which it is desired to coat with; and then, with perhaps a more powerful battery than for water, we may proceed in the usual way. For the sake

of illustration, let us suppose that a mixture of nitrate of lead and nitrate of potash, or a mixture of oxide of platinum and caustic potash, has been fused together: the question is, whether, by making the ordinary electrical arrangements, a piece of copper might not be covered with lead or platinum to any required extent or thickness.

But the most important application, by far, of the admixture of metals, is that which refers to increased mechanical strength. On this head there seems to be enormous scope for industrial development. During many years a gross error seems to have been gaining ground, to the effect that purity was an essential condition for strength in metals; but nothing can be further from the truth. The grand characteristic of purity is the power of crystallizing; so that the more pure the metal, the less its cohesive strength; of which an excellent example is afforded by zinc. This metal when quite pure, cannot be rolled into sheets, and requires, therefore, to be mixed with a very small quantity of lead before being sent to the rollers; the lead diminishes the tendency to crystallize, in the same way that stearic acid is prevented from assuming the crystalline form, by the presence of a minute portion of wax or arsenious acid. The necessity for mixing copper or some other metal with gold and silver is extremely well known; and yet this purity hypothesis, with regard to metals in general, has not only progressed rapidly, but taken deep root in quarters where more knowledge of the truth was to have been expected. Hence we have seen pure iron, pure copper, and pure lead employed, where this very purity has been the chief cause of failure. Not to mention the monster gun of Mr. Nasmyth, with its pure iron, we will relate an instance which had many illustrations to prove it:—On one of our largest railways, a contract had been made with a large manufacturer to supply the purest copper for making the fire-boxes of locomotives. The copper was sent, and the fire-boxes made; but when used were found to wear away with the most astonishing rapidity; so that impurity in the metal was at once suspected. A searching chemical analysis proved, however, that the manufacturer had only too closely complied with the terms of his contract;—the copper was absolutely pure. Again, if we regard the present state of copper sheeting in regard to ships, we see that the pure metal has been quite expelled from use by the "yellow metal," or combination of Mr. Muntz. In short, wherever mechanical strength is of importance, a pure metal is interdicted, and this too even in the case of iron. We are not ignorant that such an assertion will excite the surprise of many, and perhaps elicit the hasty contradiction of a few; but the opinion will bear discussion, and has evidence in its favor. Thus, Berzelius tells us that "le fer contenant du cuivre à plus de ténacité que tout autre;" and a patent has actually been taken out in this

country for such a mixture. Again, zinc, in minute quantity, is known to increase the strength of iron; and the same holds good with respect to gold. The best Swedish iron generally contains a little chromium or vanadium, which latter metal was, in fact, first discovered in an iron remarkable for its great strength. Not to burden ourselves, however, with examples, we will proceed at once to disclose the probable action of these mixtures upon the iron. We have seen that in the instance of stearic acid, the disposition to crystallize can be prevented by the addition of a very minute portion of some foreign substances; thus, one part of arsenious acid, will prevent the crystallization of 1,000 parts of stearic acid. In the same way the tendency of iron to crystallize may be prevented by intermixture with other metals. And the great question to be solved is,—what metals answer the purpose best? He who studies the book of nature with care will seldom lay it down without profit; and thus instructed, we direct attention to one of the most remarkable combinations of iron known to mankind.

In all the quarters of the world, as if resolved to multiply the lesson, nature has placed certain metallic masses, to which the name "meteoric iron" has been given, on the supposition that these masses have fallen from the atmosphere. Many of them are known to have lain for ages where they now are, but yet they retain their original metallic character, and seem to suffer little or nothing from the oxidizing influences of air and moisture. The composition of meteoric iron is singularly uniform, and whether near the poles or the equator, consists chiefly of iron and nickel; the latter varying from 2 to 10 per cent., with small quantities of cobalt, and (it is said) chromium. The remarkable fact that the first three metals, iron, nickel, and cobalt, are the only ones which obey the magnet, seems to establish a connexion between these masses and the name they bear, which may one day lead to interesting discoveries; but at present we wish to direct attention wholly to their apparent indestructibility, and to the great strength and ductility of the metal which composes them. To close our eyes upon a lesson of this kind is absolute folly; and as science has demonstrated to us the actual composition of meteoric iron, it follows that, if meteoric iron possesses any valuable qualities, we ought, by art to enjoy those advantages thus providentially placed before us. In other words the manufacture of meteoric iron ought to become a branch of the national industry. So far as science is concerned, this important question has not been lost sight of; artificial meteoric iron has been made, and it has been tested, so as to prove that its qualities are identical with those of the native compound; that in short it is more ductile and has more tenacity than pure iron, and is not so liable to rust or oxidize.

A mixture of 98 parts of iron and 2 of nickel has all the peculiarities of the best meteoric iron; and such a mixture was re-

commended to the notice of the British Government during what we hope may be called *the late war*. It was proposed to that Government to make cannons, &c., from artificial meteoric iron, and some measures were actually begun for the purpose of testing the value of the proposition. It is perhaps superfluous to say, that as usual, official routine, petty jealousy, and ignorance, were stronger than either the iron or the argument, and accordingly nothing was done. Now, however, the question returns to that intelligence which gives life and character to our entire constitution: the fabrication of meteoric iron is before the manufacturing industry of Great Britain—to be accepted, or to be refused.

Hitherto the difficulty of procuring nickel, exempt from arsenic, has offered an insuperable obstacle to success; but now we know that within our own shores an abundant supply of pure nickel exists. Within these few years an ore of sulphuret of nickel, devoid of arsenic, has been found near Inverary, in Scotland, and by its means meteoric iron has been made of the very best quality. This, in fact, formed part of the argument presented to the consideration of our governmental authorities. The mine of this ore exists on the estate of His Grace, the Duke of Argyll, and promises to yield an ample amount of ore when fully developed. It is now worked, and as we have before said, the produce may easily be converted into the desired compound, at a merely nominal cost. Specimens of this kind are at present before us, and extensive experiments have shown the practicability of this manufacture. So that we make no doubt of finding, in a very few years, the great lesson so long held up by nature for our guidance, brought home to the hearth of the million, in the demonstrated form of iron instruments which possess increased strength and a greatly diminished tendency to rust and tarnish. Such at least are the advantages offered by the hand of science to this interesting branch of manufactures; and it is not often that science promises in vain.

ART. IV.—A SKETCH OF THE GEOLOGY OF TENNESSEE. GOLD, SILVER AND COAL. — By RICHARD O. CURREY, M. D., Knoxville, Tenn.

(Continued from page 163, Vol. VIII)

GOLD.

THE excitement of the last two or three years in the copper region exceeded only that which had previously existed in the search of Gold.

Citico and Coqua creeks—the two heading near together in the mountains of the Ocoee district, and yet the one running

north and emptying into the Tennessee, while the other runs south to the Hiwassee, with the contiguous streams and mountains were once supposed to be the land of gold. But though the *nugget* and *lump* have as yet evaded the search of the laborious adventurer, yet frequently smaller particles have been picked off from the quartz rock, or panned out from the deposit of the creek. It appears that originally, the search was made in the sands and washings of these two creeks; but in 1854 I found that the examinations had been carried along the streams to their heads, and diligent search was being made for the precious metal in the quartz rock and chlorite slate. I found several shafts sunk to various depths, and ravines opened so as to cross the gold vein by exposing the gold-bearing quartz. In Whippowill mine, after knocking off a portion of the quartz, I had the pleasure of picking several fine specimens of gold, and I regarded the indications favorable to the future explorer. The surface of the country is very rugged. Its geological character pertains to the primordial; its rocky strata consisting of a quartz rock, associated with chlorite slate of a greenish color, more or less intermingled with cubic crystals of sulphuret of iron. These quartzose and chlorite slates compose alternating series with red sandstone and mica slate. Preparations were being made to crush the quartz for the purpose of extracting the gold; but we do not know how far the company progressed.

[SILVER.

Independent of the trace of silver ore to be found on analysis in the lead ores of Tennessee, the late Dr. Troost describes, in his Fifth Report, for 1834, two specimens of the sulphuret of silver, found by him in the waters of the Cumberland mountains. As these are the only specimens which have been found, no one having as yet succeeded in finding the source from whence they were washed, we will give his own account:

"I had the good fortune during my last excursion to make a discovery which may eventually be of great importance. Stopping for the night at the house of Capt. Eastland, on Clifty creek, on the Cumberland mountains, he handed me some small fragments of ore. As it was night, and candle-light not being fit to discriminate minerals, I told him that I should examine it when I arrived at home; they were accordingly wrapped up in a paper and marked with his name. Next morning I left that place, and passing through Sparta, I descended to the Calf-killer creek to water my horse; my attention was there attracted by something uncommon among the gravel; I dismounted and took up the substance which had drawn my attention. Not being willing to remain longer amongst the dangerous miasmata which were rising at that time from this creek, and which had infected the whole town, I did not think it prudent to examine this place further. When at home, I examined both these ores, and found that the fragment of Capt. Eastland, as well as that found by me on the Calf-killer, was sulphuret of silver—that of Capt. Eastland containing also sulphuret of lead; that found on the Calf-killer was pure sulphuret of silver covering and penetrating crystallized fluate of lime.

"The sulphuret of silver is one of the richest of silver ores; when pure, it contains:

Silver	87
Sulphur	13
	100

"I am at a loss to make any conjectures as to the locality of this ore. The banks of the Calf-killer, which creek takes its origin in Cumberland mountains, only a few miles (perhaps twenty) to the north of Sparta, are mostly composed of oolitic limestone—of which mention is made in this report—and this limestone is covered here and there by the sandstone of the coal formation, and no vein of silver or fluate of lime can be expected to be found in it. It is the same with the oolitic limestone, which is the highest strata of our mountain limestone series, in which I never found any metallic vein, or other mineral substance; it must therefore belong to some older rocks. The only stratum, for as much as I know, in which fluate of lime is found, is in Smith county. Now the perpendicular height of the Calf-killer is much elevated above the place where the fluate of lime is found, which is not far from the Cumberland river, about 400 feet below Sparta. I do not know from whence Capt. E. obtained his specimen—as he told me it was about fifteen miles from his residence."

COAL REGION OF TENNESSEE.

Passing by the consideration of any other mineral or ore peculiar to East Tennessee as well as its agricultural facilities for the present, I will next in order enter upon an examination of that portion of the Appalachian coal field lying within the limits of Tennessee.

No subject has caused greater solicitude to English capitalists, than the *possibility* that at no very distant day the coal fields of their island home would be exhausted. So rapidly has the consumption of this mineral increased for the last few years, both from the increase of population, and the extended application of steam, that many of the mines have already failed. Some of the most scientific geologists and intelligent miners were commissioned by Government to investigate this subject, and though they differed as to the probable length of time that it would require to completely exhaust the supply, they all agreed that it was an event which must sooner or later ensue. It is true that generations may pass away before it occurs; but like a wise government, there was an immediate prohibition put upon the destruction of the waste coal at the mouths of the pits, and a tax levied on its exportation. The result of such a catastrophe is more easily imagined than described. The thousands of busy hands now engaged with her looms, and spindles, and anvils, and rollers, as well as the millions of active capital employed in keeping them in motion, will be driven elsewhere ere such an event happens; and who cannot see, in the departure of these, the fading glory of the English kingdom, and the loss of her power. This is a striking illustration of the value of this single mineral. And while even the prospect of a failure strikes English hearts with terror, may we not anticipate a bright future

from the developments of this mineral in our country. From Main to Texas, there is scarcely a State that does not possess, to some extent, portions of a coal field; while in many it constitutes the principal formation.

In the Massachusetts and Rhode Island coal fields, there are estimated to be about 500 square miles. In the Appalachian, extending from New York, through Pennsylvania into Ohio, through Virginia, Kentucky and Tennessee, and terminating near Tuscaloosa, Alabama, being 800 miles in length, with an average width of 180 miles, and covering an area of more than 100,000 square miles, there are contained, at a low estimate, one million of millions tons of bituminous coal. In the Ohio river coal field, we have another immense basin, embracing nearly the whole of Illinois, southern part of Indiana, and extending across the Ohio into Kentucky; the entire area being not less than 55,000 square miles. In Michigan, including about two-thirds of the State, another field has been explored, of 12,000 square miles. In Missouri and Iowa, is still another of 50,000; while Arkansas and Texas each contain important fields. So that, supposing these 250,000 square miles of coal deposits to have an average thickness of 50 feet, we have no less than *three and a-half millions of cubic miles* of coal in the Union.

Two classes of coal are found in our country—the bituminous and the *non*-bituminous, or anthracite. The latter class is found only to a limited extent; being the kind obtained in Eastern Pennsylvania, and is said to have been found in East Tennessee. Though these two classes possess striking marks of difference, yet they are to be referred to the same origin. The same fossil plants have been found in each; and as anthracite is coal without bitumen, there has been observed a gradual increase of this property towards the western limit of the Appalachian field. The anthracite has been debituminized by its contiguity to the primordial rocks, and to its having been subjected to a great pressure during its formation. It is similar to, and is, in fact, natural coke.

The Tennessee coal field, being part of the Appalachian, is embraced within the limits of the counties of Claiborne, Anderson, Morgan, Scott, Fentress, Campbell, Overton, Grundy, Van Buren, White, Franklin, Bledsoe, Marion, Hamilton, and Rhea, composing the range of Cumberland mountains. These mountains are again subdivided, with local names attached.

The eastern base of the mountains, so far as I have ascertained, rest upon the inclined strata of East Tennessee—though in some places there intervenes a table-land of the silicious stratum and old red sandstone. As we cross the mountains, and in passing through the Sequatchee valley, we notice on its eastern side the inclined strata peculiar to East Tennessee; while across the Sequatchee river and on the western side, a hard, white limestone

is found, lying horizontally and overlapping the other strata. This peculiarity is observable throughout this rich valley—being traced as far up as Crab Orchard. Here limestone ledges present a striking contrast with the general character of the surrounding country, and may be regarded as a wise provision in the midst of these sandstones and sandy soils. This limestone possesses a peculiar structure—being composed of an infinite number of egg-like fossils; hence it has been termed *oolitic* limestone; but it possesses another fossil—the *pentremite*—in as great abundance, and it is also called the *pentremital limestone.*

This limestone is also well displayed all along the western declivity of the mountains, intervening between the shales and sandstones of the coal measures, and the old red sandstone or Devonian system below. Its absence on the eastern, and its unfailing presence on the western declivity, is a striking peculiarity. From this *pentremital* limestome to the summit of the mountains are included the coal measures. They consist of strata of coal, shale, sandstone, and conglomerates alternating with each other; there being sometimes from four to six of such series in one elevation, but of varying thicknesses. While on the western declivity of these mountains, the coal occupies almost uniformly a horizontal position, on the eastern the entire strata of coal, shale, sandstone, &c., appear to have been disturbed in some places, being tilted up into an inclined position, while in others no such action appears to have taken place, as they retain the horizontal position.

As this is a subject of interest to our citzens, I have made an analysis of several specimens of coal placed in my hands, giving, also, other analyses made at different places by other persons.

The following is the per centum of each specimen:

Locality.	Carbon.	Volatile Matter.	Ashes.
1. Pittsburg	55	38	7
2. Trade Water, Ohio river	69·05	21	9·95
3. Rock Spring, Ky.	80·56	10	9·44
4. Ohio river, near Caseyville	69·58	19	11·47
5. Addison's br. Cum. mt.	83·22	9	7·78
6. Anderson co., E. Tennessee	82	10	7
7. Crow creek	77·70	14	8·30
8. Sewanee Mining Company	79·56	14·21	6·25
9. Kimbrough's, Roane county	71	17	12
10. Gillenwater's, Rhes county	69	14	17
11. Alabama, Tuscaloosa	80·96	12·96	6

The analysis of No. 1 was obtained from Professor Johnson's Tables—Nos. 9 and 10 from Professor Troost's Reports, and No. 11 from Professor Tuomey's Report. No. 5 is the variety of coal brought to the Nashville market, and is of a compact structure, and possessing iridescent colors—No. 3 is from a new mine on Trade Water, Ky., 18 miles from the Ohio river.

Though it is known that the range of the Cumberland mountains belongs to the coal measures, yet so little has been

done for its actual exploration, that it is impossible to say where, in particular, coal is to be found. So important an element is it to become in our State welfare, that it is highly necessary that a thorough examination of this field should be made, with accurate analyses, accompanied with a special map, and sections of the entire region.

In the table of analyses I have presented specimens from those localities which are most abundantly worked. There are many others opened for the supply of their immediate neighborhood.

In the *Raccoon* mountains, on the line of the Nashville & Chattanooga Railroad from whence it is obtained for transportation into Georgia, the coal is similar to that produced from the Sewanee mines—being soft, and very readily crumbling into powder. It is admirably adapted for manufacturing purposes.

In the *Sequatchee valley* many valuable banks are opened, the coal from which is of a very superior quality. The construction of a branch railroad to the head of this valley would open to market one of the most productive valleys, as well in agriculture as in coal, to be found in the State. In the vicinity of Pikeville alone there are no less than six banks, all of excellent quality.

In *Walden's ridge*, which separates the Sequatchee from the Tennessee, coal seams are found extending from one declivity to the other; that on the eastern declivity affording the coal for the supply of the Chattanooga market.

The coal which is brought from Poplar creek and other localities in Anderson county, for clearness, purity, and value, surpasses any coal that we have yet examined. In many instances it is beautifully iridescent. It is this coal which is brought to the Knoxville market, a distance of sixteen miles by wagon, and by water a distance of about two hundred.

In *Cross mountain* and Elk river valley, the same valuable banks are found. To the west in *Morgan county*, there is an inexhaustible supply, only awaiting some facility for transportation to market, to render these excellent stock-raising lands as valuable for their mineral resources.

The opening of these banks, and the construction of railroads for its speedy and constant transmission to points, both East and West, would, in a few years, tell upon the industrial pursuits of our citizens. The construction of such a road as is contemplated in the Nashville and Knoxville Railroad, and especially if continued to the Mississippi river, would draw out from these rich storehouses, treasures that would inspirit the loom and the anvil with new life, and accelerate the speed of the plough. The construction also of the Kentucky Railroad, necessarily passing through the rich coal and iron banks of Anderson, promises a bright future

for the manufacturing interests of East Tennessee. This is a subject in which the whole State feels a deep interest, relating, as it does, to State aggrandizement and domestic comfort. Placed in juxtaposition with the iron and the copper, no one can fail to see what the results of their developments would be. Not only would capital flow into the country, but population also; until the State would become the Keystone of the South, as Pennsylvania is of the North.

In these coal measures, good millstones can be obtained from the conglomerates, and grindstones from the sandstones; while the strata of reddish and of white clay would answer admirably for burning into fire brick and fire stones.

Art. V.—THE LAWS OF THE STRENGTH OF WROUGHT AND CAST IRON. *

A PAPER on the above subject, was read at the Institution o Civil Engineers, on Tuesday, December 9, by Mr. William Bell.

In this paper, it was stated, that the chief point had been the consideration of the longitudinal, as compared with the transverse, strength of wrought and cast iron. For this purpose the whole of the experiments made up to the present time, on tearing asunder or crushing bars of cast iron, and those made by breaking bars transversely, had been taken, and from them, and the known formulæ of elasticity, such values of the constants in the formulæ had been deduced, as would satisfy each experiment individually. And by comparison a general view of the accordance or non-accordance of theory with experiment had been obtained, and some general laws arrived at.

The mathematical theory of elasticity, as given by Poisson and Navir, was assumed. By finding, for each experimental beam, the centre of gravity of the area of cross section, through which, according to this theory, the neutral axis passed, and calculating the moment of the forces with respect to this axis, the application of the formulæ to the experiments was easily made.

The first constant obtained, was the weight per square inch of the modulus of elasticity, and this, when deduced from the transverse strain, was taken from the deflexions produced by small weights, and in all cases where the beam or bar was very little strained. For wrought iron, the most comparable experiments were considered to be those detailed in the "Iron Commissioners' Report," which gave, by transverse strain, from 12,200 tons to 12,750 tons per square inch, and by extension of bars from 12,200 tons to 12,900 tons per square inch. For cast iron the

* From the Lond. Mech. Mag., Dec., 1856.

averages of Low Moor, Blaenavon, and Gartsherrie irons were from tension 6,305 tons, from compression 5,698 tons, and from transverse strain 5,968 tons per square inch. Other experiments on the transverse strain of wrought iron gave from 9,000 to 14,000 tons per square inch; whilst with cast iron the results were found to vary from 4,000 to 8,000 tons. On this point, it was stated, that Mr. W. H. Barlow, F. R. S., M. Inst. C. E., in some experiments on the neutral axis, recently laid before the Royal Society, found results nearly agreeing with the higher number.

Another mode of arriving at the value of the modulus of elasticity, by means of the bending or breaking weight of "long pillars," was also examined; the ratios of the lengths of the pillars to their diameters being taken as abscissæ, and the bending weights, obtained both from theory and experiment, as ordinates. It was thus found that, for the experiment on wrought iron pillars given in the before-mentioned report, the curve of theory agreed very well with the curve of observation, until the length became shorter than seventy times the thickness. The experiments on cast iron pillars examined were those in the second volume of "Tredgold on Cast Iron." The correspondence with theory was very good for those with the ends rounded, until the length became shorter than twenty times the diameter; and for those with the ends flat, until the length became shorter than fifty times the diameter. The hollow cylindrical pillars, with one exception—that of a short pillar—gave values for the modulus of elasticity of from 4,350 to 6,680 tons. The correspondence between theory and experiment seemed, in the author's opinion, to warrant the conclusion that the theory was perfectly trustworthy when only small compressions and extensions were concerned.

The fundamental assumptions usually made in the theory of the strength of materials were then considered. First, that in a beam strained transversely, the extensions and compressions of the particles were proportional to their distances from the neutral axis. Second, that the extensions and compressions were proportional to the tensile and compressive forces—known as Hooke's law, and by the phrase, *ut tensio, sic vis.* And third, supposing the latter law to hold good, that whenever in a beam subjected to transverse strain, the tension or compression on the outside particles was the same as would be obtained by direct experiment on pulling asunder or crushing bars of the same material, the beam gave way. It appeared, however, from experiment, that for large compressions and extensions, the law of Hooke ceased to be applicable. It was found that in cast iron, this law did not differ widely from the truth within the range of the experiments; whilst in wrought iron, although the difference was great near the point of rupture, yet the curve of compression was similar in form to the curve of extension, the ordinates likewise being nearly

equal in amount. The true law might, therefore, be roughly expressed by saying that, beyond a given amount of force, the same force corresponded to all compressions and extensions, this force being nearly the force of rupture, either by longitudinal compression or extension: in other words, the force was scarcely altered by a large increase of the compression or extension. It was next considered what effect this deviation from the law of Hooke would have, as to the force on the outside particles, as deduced from that law; the supposition being made that the force was constant, and therefore equal to the force of rupture for all compressions or extensions. From this investigation, the author thought it would be obvious, that the supposition of a constant force was different from the truth in one direction, while the law of Hooke was different from it in another, so that these two laws formed limits between which the truth always lay; in cast iron the latter law being more nearly approximated to it. It was shown that the results derived from experiments, by assuming the ordinary law, were slightly above the truth, the difference, even in a rectangular section of wrought iron, being probably less than 20 per cent., and in cast iron still smaller, while in large box and double T girders with a broad bottom flanch, the difference was practically insensible.

The other constant obtained was the value in tons per square inch of the tension and compression of the outside particles, when the beam became ruptured by transverse strain. For wrought iron the experiments on solid iron bars were fewer than could be wished, and gave results varying between 14½ and 18½ tons per square inch. In this material it was thought that it might probably be the compressive, rather than the tensile force which determined the fracture. The only experiments on the direct compression of wrought iron were those on two bars, given in the Iron Commissioners' Report—where one gave way under a strain of 14·5 tons, the other under 13·8 tons per square inch. The quality of iron was not stated, but it was believed to have been soft. It was asserted that the better kinds of wrought iron were able to sustain a greater tensile force, the worse kinds a greater compressive force. According to Mr. Eaton Hodgkinson's experiments, wrought iron might be defined to have its tensile to its compressive force, nearly in a ratio of equality; cast iron to have those forces in a ratio of about one to six. This being so it was thought worthy of consideration whether in the plates of a large wrought iron bridge subjected to compression, a slightly inferior quality of iron might be used, not only as more economical, but as better in itself.

With regard to riveted iron, the results from all the wrought iron tubes in the before-mentioned report, gave from 7·1 to 24·8 tons per square inch. The lower numbers were apparently caused by using thin plates for tubes of comparatively large diameter.

If this were avoided, it was thought that in calculating the strength of wrought iron tubes, 15 tons per square inch might be allowed for the breaking force on the outside particles.

When the experiments on cast iron were examined in this manner, the following fact became apparent; experiments on small bars broken transversely gave results of 20 tons, and even more, for the tension and compression of the outside particles, when the experiments were examined by the ordinary theory. If these results were diminished by 20 per cent., which it appeared would more than make up the difference caused by assuming the ordinary law, there was still a result of, say 16 tons, while by direct experiments on the tensile force of cast iron, 7 or 8 tons were found to be the utmost that it would bear. In regard to this subject, Mr. W. H. Barlow had adduced the alternative hypothesis that the neutral axis shifted its position as the beam became strained, and that when rupture took place the neutral axis was "at or above the top of the beam." This hypothesis was considered by the author to be contrary to the elementary principles of mechanics; for as the sum of the compressive forces on one side of the axis must be equal to the sum of the tensile forces on the other, therefore if there were tensions on one side of the axis, there must be an area out of which to get compressions sufficient to balance them on the other. As evidence on this point, in one material, the observations of Sir David Brewster in passing polarized light through a piece of glass subjected to transverse strain were alluded to.

In experiments on the direct tensile strength, it was assumed that the outward force was uniformly distributed over the area of the bar; in other words, that the resultant of the external forces acting on the bar, passed through, and had the same direction with the axis. This probably obtained in wrought iron from its great extensibility before rupture; but in cast iron there was no such extensibility, and this point was, therefore, to some extent, doubtful. If a few experiments were made, in which the force deviated from the axis by certain large and measurable amounts, and then were made to approach the axis, until some law was obtained which could be tested, this point would be set at rest. A table was then given, showing the values of the forces on the outside particles at the time of rupture, in tons per square inch, from which it appeared that there was a diminution as the size of the beams increased. Beams 3 inches by 3 inches, as compared with those of 1 inch by 1 inch, showed a falling off of strength to the extent of about 4 tons per square inch. The results derived from Mr. Hodgkinson's and Mr. T. Cubitt's experiments gave about 10 tons per square inch, when the sound beams only of the latter experimenter were included in the calculation, or 9·6 tons per square inch when the unsound beams were taken into account. From this table it appeared, that the breaking

weight of tolerably large girders might be calculated with considerable accuracy, by using 7 or 8 tons per square inch as the force of tension on the outside particles, when rupture took place.

In conclusion, the author expressed the hope that he had succeeded in establishing the following propositions:

First. That in experiments where the materials were but slightly strained, theory and experiment coincided.

Second. That where the ordinary theory was applied to the rupture of beams, and especially large beams, of wrought iron, theory and experiment practically coincided.

Third. That there appeared to be no good reason for supposing that the neutral axis shifted its position to any extent worth noticing, even up to the time of fracture.

Fourth. That in cast iron, although theory seemed to differ from experiment, when the transverse strength of small bars was compared with the direct tensile strength, assuming the latter to be correctly stated at 7 or 8 tons per sq. inch, yet when the transverse strength of large girders was compared with the direct tensile strength, the coincidence of theory and experiment was nearly exact.

Fifth. That the ordinary theory of the strength of materials was more trustworthy than was generally supposed.

In an appendix, the author explained the formulæ used in examining the experiments, and gave the demonstrations of the results arrived at; the experiments for ascertaining the modulus of elasticity, and the forces on the outside particles at the time of rupture, being examined in great detail.

Art VI.—CHIRIQUI IMPROVEMENT COMPANY*—REPORT OF PROF. NEWTON S. MANROSS.

Gentlemen:—In pursuance of your instructions, the party under my charge, proceeded to examine the deposits of Coal in the vicinity of Chiriqui Lagoon, as soon as the necessary preparations could be made after our arrival at Bocas del Toro. Our first ex-

* This Company has been organized under an American charter, to take possession of certain grants and privileges made in the Province of Chiriqui, in New Granada.

These grants, privileges, and charter are set forth in full detail in a pamphlet issued by the Company.

The Province of Chiriqui is upon the Isthmus, about equidistant between Chagres or Aspinwall, and San Juan or Grey Town.

The lands enclosing the Lagoon of Chiriqui are mostly contained in the grants. These lands were believed to contain inexhaustible mines of bitu-

pedition embraced the entire circuit of the Lagoon, including the localities of Split Hill, Endeavor Creek, Secretary and Pope's Island. A second short trip was made to Cultivation Creek, on Shepherd's Lagoon. The third was to the Changuinola River. A fourth excursion, to the Cricamola, was undertaken in consequence of a report that coal was formerly discovered and used there.

I shall describe the deposits in the order of their geographi-

minous coal; but the Company did not deem themselves warranted in disposing of their shares, or providing large means to develop these mines, until a geological examination should give positive value to their proceedings.

Professor Manross (recommended and vouched for by Professors Silliman and Hitchcock) was therefore dispatched to the Lagoon of Chiriqui. He was accompanied by Captain Bonner, Mining Engineer.

A defined extent of territory, which was then supposed to be all that required examination, was named to these gentlemen: they determined, in advance, the time necessary to explore this, and engaged themselves only for that period. Very shortly after their arrival in Chiriqui, it was ascertained that this time was not sufficient. New instructions were immediately sent out. Unfortunately, the delays and detentions incident to a new route prevented their reception in Chiriqui until Messrs. Manross and Bonner had left. Consequently, that full and detailed examination which the Company desired, was not made, of the whole of their lands. Enough, however, was accomplished to establish the following:—

1. Coal of superior quality, having all the characteristics of Cannel coal exists, in inexhaustible quantities.

2. That it abounds in the most favorable places for mining, and can be mined at a cost to defy all competition from England or the United States, and be delivered from the very mouths of the mines into the largest class vessels.

3. That the Company are possessed of the best route across the Isthmus, wit the finest harbors at the termini, that has yet been discovered.

From these important facts, the following results may be deduced:—

1. The entire coal lands being in the possession of the Company, no competition in them, or in their production, can arise against the Company; and hence, the Isthmean supplies of coal on both sides must be under their control.

2. That the possession of the best harbors on the Atlantic and Pacific coasts of the Isthmus, nearly opposite to each other, and the control of the coalfields, will cause the early construction of a road which will afford the only certain and reliable transit, as between England and Australia and the Atlantic ports of the United States and the shores of the Pacific, over this dividing strip of land.

3. That the rich gold lands owned by the Company will be peopled by a hardy race of miners from Europe and America; and that the broad, healthy and productive savannas of the Pacific slope, at this point, will be not less remunerative to the agriculturist.

These results stamp the enterprise of the Chiriqui Improvement Company with the highest value, and of vast interest alike to Europe and America.

For information in further detail, reference is made to the following report of Professor Manross; to the letter of Doctor McDowell; to the report of James B. Cook, Civil Engineer; to the accompanying maps and views, and to the pamphlet of the Company before referred to, containing copies of its grants and charter.—*Report of the Co.*

cal position, commencing from the East, and prefacing the descriptions by some general remarks on the character of the formations in which the beds occur. The report of Mr. Bonner, my assistant and companion, has been consulted in the preparation of this.

From the most easterly point examined, that at Secretary, to the most westerly, the Changuinola River, there is an unmistakable uniformity in the character of the rocks which line the coast. They consist of sandstones and limestones, more or less indurated, and variously inclined by intruded ridges of trap. The sandstones are mostly thick bedded, and nowhere assume the form of shales. These formations are narrower towards the east, being confined to the promontories of Valiente Point and Saddle Hill, and to the islands in their vicinity. They were nowhere detected on the southern or mainland side of Chiriqui Lagoon. That shore is occupied quite down to the sea, by mountains of gneiss, sienite, and other ancient rocks. At the western extremity of the Lagoon, the sandstone formations join the mainland, and from that point, to the Changuinola River, they exhibit a constantly increasing development in breadth and thickness. At Valiente Point, the breadth of the formation appearing above the sea, is from two to three miles. On the Changuinola, it is not less than ten. In some parts the strata attain an elevation of more than one thousand feet above the level of the sea. The length of the tract included in these limits, is nearly fifty miles. All the islands of Admiralty Bay belong to the same formation. There was no lack of evidence to fix the age of the strata throughout this entire distance. Many fossil shells were found, of species now existing in the adjacent waters; and trunks of trees, in a partially carbonized state, occurred both above and below beds of coal. They were apparently of the same varieties as are now growing over the spot. Leaves of dicatyledonous trees, and fruit of a modern species of palm, were taken from the soft strata, in contact with one of the coal seams. None of the peculiar fossils of the older coal formations were detected in these rocks. These evidences, together with the lithological character of the rocks, are sufficient to show that the formations are not of greater age than the older tertiary, and that the coal of this region is therefore similar to that so extensively worked in France, Belgium, and many parts of Germany.

The most easterly point at which coal was observed, was at Secretary—a place on the interior shore of Valiente Promontory.

There three separate beds crop out upon the beach. The most easterly, and, at the same time, the highest in the series, appears in the face of a cliff some forty feet high. A complete section of this bed is afforded by the freshly broken precipice. It is situated about twenty feet above the water. It has a thick-

ness of about four feet, and is exposed for a length of ten or twelve yards. A second and thicker bed is exposed at the edge of the water, a little distance west of the former. The upper surface of this bed has been laid bare by the action of the sea, and may be seen under the water, several yards from the shore. It slopes upwards into the land at an angle of about twenty degrees. Judging from the slope of this bed, as compared with that of the overlaying rock and soil, it must crop out within one hundred yards of the sea, but its out-crop could not be detected on account of the dense covering of soil and vegetation. A pit sunk through it, at high-water mark, showed it to be six feet in thickness, although the lower two feet of this was much mixed with sand. A tunnel was driven a few feet inland in the bed, without bringing to light any new characteristic.

The third and lowest bed is situated also at the edge of the water, about a hundred yards west of the second. It is two and one-half feet thick. All of these beds, as also the enclosing strata, have a direction parallel to the shore of the Lagoon. Their positions are indicated on the accompanying map. The coal of these veins is of a soft and bright quality, and extremely interesting, showing the considerable thickness which the seams may attain in this formation.

Following the course of the formations wesward, in the direction of Saddle Hill, coal is again met with on Pope's Island. It occurs there in a bed of from five to six feet thick, being, exposed, as usual, by the action of the sea. It is of a much harder and better quality than that at Secretary. Its course is N. W., with a dip of 20 degrees N. E. This bed bears marks of disturbance, being bent and reduced to a foot in thickness, where it appears in the cliff above the water. Whether it regains its thickness, and continues on in the direction of its strike across the island, is a question which can only be decided by the operations of an adequate mining force drifting in upon it, and sinking shafts on its line of bearing. If continuous, it will have a length of about two miles upon the island, and a "back" of from 50 to 100 feet. The superior quality of this coal, and its favorable location, render this the most important point in that vicinity for further explorations.

Still further west, on the promontory of Saddle Hill, several beds of coal occur at distances of from half a mile to a mile from the inner shore of that promontory. This range of beds includes the localities of Split Hill, Two Serpents Creek, and Endeavor Creek. It covers an extent of four or five miles in length. In the first of these localities three beds of coal were seen, cropping out in the beds of streams. They varied from one to two feet in thickness. In the second locality, three beds were also distinguished; one of them had a section of four feet. These two localities are about two miles apart. At a somewhat greater dis-

tance occur the beds at Endeavor Creek, the most westerly locality upon Chiriqui Lagoon. Here, also, three beds were detected, varying from three to five feet in thickness. They, like the others, have a direction parallel to the shore, and dip towards it. In this vicinity, at least twelve outcroppings of coal were observed in the different creeks and gullies—all of them, however, referable to the three beds above described. It may be safely presumed that the coal seams are continuous, as the enclosing strata certainly are, over the entire space included by the localities last named. The coal is, however, of a soft character, and inferior to that of Pope's Island, or the localities hereafter to be described.

Another locality of coal was examined on Cultivation Creek, about one mile from the shore of Shepherd's Lagoon. The seam is about one foot in thickness, and exhibits a quality superior even to that of Pope's Island. It is hard, brilliant and compact, and would undoubtedly answer well for purposes of steam navigation. The small size of this particular vein precludes the hope of its being in itself of value, but its good quality, together with its position, in strata thoroughly indurated, and rising to the height of several hundred feet above the level of the sea, encourages the belief that other and larger beds will be found in this vicinity. I would particularly recommend this region for further examination.

No other localities of coal are known to the westward of Cultivation Creek, till we arrive at the deposits on the Changuinola River. The intervening space is *unquestionably occupied* by the same formations, as is shown by the form and direction of the mountain chains, but it has *never been explored for coal beds, although certain to contain them.*

The first locality visited upon the Changuinola, is situated at a place called Jinia. A single seam is exposed at intervals, along the bed of a creek, for a distance of several hundred yards. The coal is hard and brilliant, and remarkably free from impurities. Although the thickness of this bed, where exposed, is too small for successful working, the fact that it maintains its thickness, direction and quality uniformly, over so considerable a space, is a highly encouraging feature in the formations. Still higher up the river, we encountered the largest beds of good coal which have as yet been discovered in this locality. They are exposed in the bed of a branch of the Changuinola, called by the Indians "Sierschick." The seams cross the stream obliquely, and appear in either bank, as well as for a short distance up the hills. On the east bank there are seven veins, varying from one foot to eighteen inches in thickness. They are distributed through a mass of strata forty feet thick. On the west bank, the seams of coal are assembled into three veins, of from two to three feet each, occupying, with the intervening rock, a thickness of twenty feet.

he dip of the bed is a few degrees east of north, and amounts o thirty degrees. The spot is four hundred and thirty-four feet bove the level of the sea. A bed of coal was also visited, several miles further up the creek, at an estimated elevation of seven hundred feet above the sea. A landslide had covered the spot, so that only a few fragments of the vein could be seen; but these were of the same bright and hard quality as the places lower down. The coal of the larger beds described above, is hard and compact, possessing considerable brilliance in its fracture, and sufficient firmness to bear transportation. It has a specific gravity of 1.27, and contains from 6 to 7 per cent. of ash. It burns freely, with a strong flame, but does not melt. The ash is grayish white, without any tendency to form clinker. The analysis of it, in the possession of the Company, shows that it compares favorably with many of the coals of the older formations. I have no doubt this coal will answer the purposes of steam navigation, as well as nearly all the requirements of the arts and manufactures. The three seams described as occurring so near each other at the principal locality (of the Changuinola, if united in one, would form a bed sufficiently thick to be taken out with advantage. The irregularity of the included beds of rock, seems to promise that they may unite, or at least approach near enough to be worked as a single bed.

It is to be regretted that the limited time allowed for the explorations, the insufficient force of miners, and the unfavorableness of the season, rendered it impossible for our party to make such a thorough examination of the extent and continuity of the more promising of these veins, as their geographical position and vast financial and commercial importance demands. Sufficient has, however, been done to show that considerable quantities of coal, of good quality, do exist at the localities described; while the vast extent of country over which the containing rocks have been shown to extend, leaves ample room for the expectation that the discovery of other and still larger beds will reward the enterprise of your Company.

GOLD DEPOSITS AT CATABELLO.

In the course of the excursion up the river Cricamola, we visited and examined a region where gold was reported to exist. We saw there several small streams, from all of which we obtained gold by panning. The yield was about forty cents per bushel. According to Mr. Bonner's estimates, the deposits examined contained about three thousand cubic yards of such sand. The streams formed a part of the head waters of the River Catabello. No opportunity was had of examining the other streams which flow from the same range of hills, but gold would doubtless be found in all of them. The streams rise near the summit of a ridge so situated that the gold could not have been transported

from any remote place. It might, undoubtedly, be easily traced to its source in the underlying rock. Many grains of platina were found among the particles of gold. Considering the probability that these gold deposits extended over a considerable space, as well as their satisfactory richness where examined, I recommended Mr. Morel to secure, by denouncement, the entire tract, including all the head waters of the Catabello, and that river itself, as far down as there would be any prospect of its yielding gold. A small sample of the gold accompanies this report.

OBSERVATIONS ON THE LINE OF THE PROPOSED ROAD.

After prosecuting the explorations upon the Atlantic coast as long as the season permitted, it was decided to cross to the southern side, thereby obtaining a complete section of the rocks of the Isthmus, and at the same time viewing the reported coal deposits of the Pacific coast.

Finding, on arriving near David, that the parties who had discovered coal upon the Golfo Dulce were absent, and that in consequence no explorations could be undertaken with advantage in that quarter, we returned to the Cordillera, and ascended a peak called the Boquete. This peak commanded a view of both seas, of the Lagoon of Chiriqui, of David, and of the entire line of the proposed road, from ocean to ocean. The summit of the peak is sixteen miles in a direct line from the Chiriqui Lagoon, at the mouth of the Robalo River. Its place is indicated in the accompanying map. It is, consequently, much nearer the Atlantic than the Pacific coast. On the southern side a most remarkable slope of ground extends from the foot of the Boquete down to the shore of the Pacific.

I have never seen anything in the natural conformation of a country more singular than this inclined plane, or more singularly adapted to the construction of a road. The average ascent is not more than three feet in a hundred, and this is continued with the utmost regularity quite up to the summit pass. The plain is separated from the mountains on either side, by rivers running in deep ravines, which catch the drainage of the hills, and leave the slope unbroken by streams or gullies. Only three bridges would be required from the harbor at David to the summit of the Cordillera.

The sketch of this region, by Dr. McDowall, which was shown me in the Company's office, is a faithful representation of this remarkable natural grade.

In that sketch, it will be seen how the smooth and even tongue of land which I have been describing, stretches up between and beyond the highest mountains of the Isthmus range. The double-pointed peak, in the centre of the picture, is the Bo-

quete, from which my observations were made, and the little sketch which accompanies this, taken.

This sketch represents the view from the summit of the Boquete, looking northward to the Lagoon of Chiriqui, on the right, and the islands of Bocas del Toro, on the left. It will be seen from it, that a curved valley extends from the pass at the foot of the Boquete, quite down to the Lagoon of Chiriqui, at the mouth of the Robalo. A road along this valley, from the mountain to the sea, would not be more than nineteen or twenty miles in length. One-half of this would be laid in the almost level lower valley of the Robalo. The other nine or ten miles would be mountain road, and would require to be cut in the sides of the valley, and, of course, to follow its winding. It will be seen, from this slight description of the country, that a large part of the work of constructing a road across the Isthmus, at this point, has already been done by the hand of nature.

On the southern side a natural inclined plane of most remarkable character winds up from the shore of the Pacific to the summit of the Cordillera. On the Atlantic side, a river valley affords another equally advantageous grade for half the remaining distance; while the upper ravines of the same river offer a passage to the summit, where the Pacific slope terminates. I estimate the length of the road at fifty-five miles. Three-fourths of the entire distance is thus graded by nature. For the construction of a road, the Isthmus is, therefore, practically narrower at this point than at either of the other places where roads have been built or projected. Terminating, as this route does, in magnificent harbors on either coast, it might easily be made one of the great transit routes from ocean to ocean. Two-thirds of the distance will be through a country affording natural pasturage throughout the year, and having a soil unsurpassed in fertility. The other third will open a forest abounding in timber of various kinds, some of which have long been known to commerce, while others, equally valuable, but growing in the interior, only wait for an outlet to have their value acknowledged.

The very best materials for macadamizing are found in abundance along the entire line of the road. Its construction would be comparatively inexpensive; and I am fully convinced that such a road, with the unlimited supply of horses, oxen and mules, which the immense tracts of natural pasture belonging to the Company would produce and maintain, at a trifling cost, would compete successfully, even in the transportation of heavy merchandise, with either of the transit routes now open, or to be opened. It should become one of the great channels of trade between the Atlantic and the Pacific.

Report by ROBERT MCDOWALL, M. D., *residing at David, Province of Chiriqui.*

Of all the provinces that constitute the Isthmus of Panama, there is none more pleasant to the eye, more valuable for its geographical position, for its agricultural capacities, and topographical superiority, than the province of Chiriqui; one of the first points of the American Continent touched at by Colon, and yet at this present day scarcely known. It has one of the finest harbors in the world, (a matter of the highest importance, especially on the Atlantic Coast of the Isthmus,) called the Admiral's Bay, on one coast, and secure roadsteads on the tranquil Pacific. It lies betweeen 7° and 9° north latitude, and 81° 5' west longitude; limited on the east by the province of Veraguas, north by the Atlantic, south by the Pacific, and west by Costa Rica. The Cordilleras divide it into two unequal parts, north and south. The northern, about one-third of the entire width, is the region of the Cordilleras, from the foot of the latter to the border of the Pacific, consists almost entirely of extensive plains, formed by a gradual descent of the land from the mountains, until lost in the level of the South Sea. Population is all that is required to make the desert smile like the rose. Look at these immense plains, bounded north by the majestic Andes, far off in the distance, below the twinkling Polar Star on the one hand, and the great Southern Sea, stretching away towards the coast of "Rich Cathay" on the other; covered only by grazing cattle, with little or no cultivation—though from the oak region of the Cordilleras, down to the mangroves on the sea-side, the industrious farmer could select just exactly the soil and temperature he requires.

The population of this province is about 20,000. David is the principal town—Dolega, Alange, Gualaca, Los Remedios, Tole, and one or two small villages are not of such importance; the first, Dolega, about a league from David, nearer the Cordilleras, is remarkable for the longevity of its inhabitants, many of whom have lived more than a century. The life and customs of the original inhabitants are simple and pastoral, whose uniform tenor is only broken occasionally by the processions and feast days of the Church—their religion being purely Roman Catholic.

There are five races of Indians that inhabit the mountainous regions bordering upon the Atlantic, from Bocas del Toro, to Cape Gracias a Dios. These different tribes are known by the names of Caribes, Mosquitos, Blancos, Valientes, and Guaimies; these last are most known, as they are in the habit of visiting the towns of the province to exchange fishing nets, bags, resins, sarsaparilla, &c., for common calico, drills, &c., to make clothing for their families. On the discovery of America the Indians had gold in abundance; but now, such is the horror that the traditions

of their fathers have inspired against this metal, so fatal and destructive to their race—that no consideration will tempt them to touch, or give the least information to a white man about their ancient mines. These Indians invariably inhabit what are called the "tierras baldias," or government lands. They seldom or never make their towns in the plains.

The principal products of the province are Indian corn, rice, and dried beef—the greater part of which is sent to Panama. The mode of preparing the land is by burning, similar to that used on the coast of Africa; a mode not only defective in itself, but ruinous to the best timber of the country. Cocoa and coffee produce very abundantly, and the quality of the sugar, made without the least knowledge of refining, speaks greatly in favor of the soil and the sugar-cane; cotton, also, of good staple and quality; the caoutchouc tree abounds on the coasts of both oceans; sarsaparilla, croton and castor oil, balsams of copaiba and Peru, with many other valuable medicinal plants, abound in the forests; palm oil, with the aid of a press, could be exported in considerable abundance. The mountains, besides, afford very rare and curious plants of the orchidean family, including the fragrant vanilla and bignonia; all of which could be easily shipped to order, to supply the increasing wants of intellectual luxury.

A few analytical experiments on a small scale have shown the mineralogical constitution of the country to be no less interesting. Coal of a good quality is found on one of the islands, "Muerto," near the port on this side. We have evidences of the existence, in more or less abundance, of platina, gold, nickel, tin, vanadium, barium, and other rare metals, one of which seems to be new, differing from all the known habitudes of other metals; it seems, however, to have been known to the ancient Indians, as we find in their graves alloys of this metal with copper, in the form of bats, frogs, &c., quite unoxydated; it resists acids for some length of time—has almost the color and specific gravity of gold itself. For domestic and other utensils it would be far more eligible than all the hitherto compositions in imitation of silver; united with lead, it makes an excellent drawing pencil.

What is most essential, then, to make available all these untroubled riches? First, *a Road* that shall open up intercourse between these fine plains and the Atlantic. Secondly—Inhabitants to make use of the vast acres of unoccupied lands. For these great benefits the people of this generation look to your philanthropy, energy, and enterprising genius. All are anxiously awaiting the result of the Road privilege now in your possession.

Report on the proposed Chiriqui Road, by JAMES B. COOKE, *Chief Engineer, etc.*

The route to which I have reference lies between 7 deg. and 9 deg. north latitude, and 81 deg. 5 min. west lon.; on the east limited by the Province of Veraguas, north by the Atlantic, south by the Pacific, and west by Costa Rica.

With regard to geographical position, there is none on the Isthmus of Panama that can compete with the Province of Chiriqui, and for the construction of a road, its topographical facilities have by far a superiority, as I will afterwards show; for agricultural pursuits, its soil and climate are pre-eminently suited above all others in the tropical world—for there the farmer can choose just the climate he may require, from the most northern to the most southern, with all the interm ediate temperature best suited to h's pursuits.

There are, in my opinion, ample engineering facilities for the construction of the road: two-thirds of the road require little or no heavy work; the other third, passing over the Cordilleras, requires, in several places, cutting and embanking, in order to render it level: twenty-seven miles from the Pacific to Caldera, the plains, are gradually elevated, the grades not exceeding in any place the rate of one in sixty-three feet. At Caldera, the passes are entered, and the road sweeps round the mountain spurs, or over their slight undulations, at grades varying in ascent or descent from one in thirty-five to one in fifty feet, for a distance of twenty-four miles; thence onward to the Lagoon, at grades of from one in fifty feet to one in sixty-five feet. It must be borne in mind that these are all natural grades; excavating and embanking would reduce them to a regular line of ascending grade to the dividing pass of the Cordilleras, and from thence in a descending grade to the Lagoon—neither of which grades would exceed twenty feet to the mile: but as these grades now exist, they are not very unfavorable to a railroad, but more favorable to a Macadamized road than if reduced to one gradient line of ascent and descent.

The curves of the lines are favorable to either kind of roads, being of sufficient radius to permit nearly the whole speed of travel. The entire length of the line is sixty-two miles, four chains and twenty-five links.

On the Pacific side, in the neighborhood of the Golfe Dulce, there is a magnificent harbor with deep waters, and well sheltered, requiring but little engineering to render it applicable for the purpose of the road.

On the Atlantic terminal point of the road, there is no place to be found upon the Isthmus so well adapted for a harbor; it is well sheltered from the devastating northers and hurricanes of the tropics, and no harbor can be found excelling it in beauty,

deep waters, of ready and well-defined entrance, and other natural advantages—not the least of which are streams of the finest and most delicious fresh water, poured down in never-failing supply from the mountain slopes. This same advantage also exists at the point selected on the Pacific; and, indeed, throughout the whole extent of the road, there is a succession of mountain streams—none, however, presenting serious obstacles to its construction, but affording to the road a supply rarely found in elevated countries.

Though rapid in their courses, these streams do not run out or exhaust themselves in the dry season. The reason of this is obvious: the peaks of the lofty mountains, rising some thousands of feet above the line of the road, penetrate the dense masses of vapors thrown up by the rapid evaporation of tropical climates, and form conductors around which is condensed the irrigated supply of the valley below. To this constant coursing of water may also be attributed the extraordinary healthfulness of this entire route across the Isthmus; no other compares with it. The crossings of Tehuantepec, Guatemala, Nicaragua, Darien and Panama, are, throughout nearly their whole extent, subject to fevers and maladies of the most fatal character; the decaying matters of their swamps and marshes impregnate the air with their destroying miasma, and the adventurous stranger who seeks the alluring gold-fields of California and Australia, too often finds his grave upon the narrow strip which divides these great oceans. Not a marsh or swamp or putrefying place exists from ocean to ocean on the Isthmus of Chiriqui. The Chiriqui road will then, when finished, from these natural advantages, secure to itself the great travel not only from the cities of the United States to California, but also from England to Australia and the East Indies. Nor does the Province of Chiriqui offer less inducements to the immigrant to settle within its borders, than will its road to the voyagers to distant lands.

Rich and fertile plains, from which spring in the most luxuriant growth, the coffee tree, yielding in abundance, after three or four years' culture, a berry of extraordinary flavor; the tea plant, growing wild, requiring but the hand of industry to make it most productive; *cotton*, *rice* of large grain, *tobacco*, *flax*, *maize or Indian corn*, the *English or small grained corn*, *wheat*, *Irish and sweet potatoes*, *peas*, *beans*, *cabbages*. Besides these, there are various spices, including *ginger*, *pepper*, and a great variety of botanical and medical plants. The slopes of the mountain ranges afford pasturage of the best description, and thousands of cattle feed wild upon their sides.

In mineral wealth the country is exceedingly rich. In my explorations, I found indications of gold in the greatest abundance, existing in the river beds in dust and scales mingled with sand, which slight washing readily removed; gold-bearing quartz,

in large quantities; and various places were discovered apparently very rich in the precious metals. Platina is found in large quantities, and I had also ample evidence of silver, mercury, antimony, molybdenum, barium, copper, tin, and iron ores. Coal is also to be found on both the Atlantic and Pacific. With regard to these coal formations, those on the Atlantic are very abundant and rich, covering a large area of ground.

On the Pacific side, it crops out in the Island of Muerto; but I am of opinion, from examinations I made, that near David, along the line of route, abundance of coal, and of good quality, may be found.

After a careful analysis, I found these coals to be composed as follows:

	Muerto Coal.	Atlantic Coal.
Volatile and bituminous parts	34·12	37·29
Solid carbon	59·38	56·53
Ashes	6·50	6·18
	100	100
Yields in coke	64·43	67·43

Red clay, of great fineness, for the manufacture of bricks, exists in the most abundant quantities on both the Pacific and Atlantic sides. Fire clay is readily found; pipe clay, and various other substances, all useful and abundant.

The surface of the country is well covered with forest trees of every description suited for building purposes, amongst which may be noticed those woods of great durability: the *Nisperos*, *Zapadilla*, and gigantic *oaks*, of close grain, strongly resembling the live oak, *cedars* of large diameter and perfectly straight stems, of from sixty to eighty feet before a limb starts off from the main trunk, *mahogany*, *satin wood*, *ebony*, *sandal wood*, and a variety of others; also resinous *gum trees*, of vast variety, *logwood*, *fustic*, and many others of great value, *tortoise shell*, *mother of pearl*, of large size and great value: the shell which produces the ancient and greatly valued Tyrian purple dye, is also found in abundance in the Pacific waters bordering the terminal points of the road.

That which has already been so briefly alluded to, is sufficient to show that there is ample local advantage to secure prosperity to the road, without even that enormous trade and travel which must inevitably pass over it; for it is destined to be the central, the all-absorbing course which travelers and merchandise must pursue between the great markets of the globe. The natural position, formation and productions of this region having, with its entire healthfulness of climate, stamped it as the point of transit between the two oceans, the only question left now, is the kind of way or mode of transit which should be established.

From a careful examination of, and deep reflection upon the entire subject, I have come to the conclusion, that a Macadamized road is the only one which ought, at the present time, to be made. The material for it through the mountain passes, lies ready for use.

In this opinion I am sustained by the valuable report of Mr. McGeechy, Crown Surveyor of Jamaica, and Capt. Liot of the Royal Steam Packet Company. After a careful survey of the Isthmus of Panama in 1844, the gentlemen use these words in their report: "The most practicable and economical way of transit across the Isthmus, would be a good Macadamized carriage road." The route across the Isthmus of Chiriqui was not at that time before the public; had it been, and could the attention of these gentlemen have been directed to it, there is no doubt that a safe, economical and healthy route would long since have been in perfection over this beautiful and delightful region of the tropical world.

With a cash capital of 4 to $500,000, and the whole expenses of constructing, such as for bridges, wharves, piers, stabling, toll-houses, drainage, &c., and all things incident to the construction of a Macadamized road, would be amply sufficient, and with a proper force the road could be opened in eight months from the time of commencing, and in a period of twelve months the road could be put in complete working order.

In conclusion, from the examinations and explorations I have made upon the Isthmus generally, I have found no spot to equal it, both as regards its climate, soil, and commercial position, and the lands contiguous to the line of route possess all the advantages for the settler, where but the hand of labor is alone wanted to till the soil which is so richly spread around.

ART. VIII.—THE PRACTICAL MINER'S GUIDE, &c. BY J. BUDGE. No. 1.*

INTRODUCTION.

IT is an acknowledged fact, that dialling, in all its varieties, is the most difficult and momentous part of the duty of practical mine agents: to assist them in that important operation, is the chief design in giving publicity to these tables.

* We commence, in the present number of the Mining Magazine, the republication of the Practical Miner's Guide, by J. Budge, and shall continue its republication in each successive number of the Magazine, until it is completed. It is a 12mo. volume of 218 pages, leaded, and printed in large type; each page will occupy nearly a half page of this Magazine. It will be completed in about eight numbers of the Magazine. The price of the English edition is

Notwithstanding the great improvements which of late years have been made in the art of dialling, the most intelligent miners universally admit, that the practice is still very imperfect; nay, so far are they from any determinate and general system, that

$3 50. No edition has been or is likely to be published in this country, except this, which we herewith commence.

The Practical Miner's Guide: comprising a set of Trigonometrical Tables, adapted to all purposes of Oblique or Diagonal, Vertical, Horizontal, and Traverse Dialling, with their application to the Dial Exercise of Shafts, Adits, Drifts, Lodes, Slides, Levelling, Inaccessible Distances, Heights, &c. Also, a Treatise on the Art and Practice of Assaying Silver, Copper, Lead, and Tin, with Tables which exhibit at one view the Value of Assayed Ores: Rules for Calculating the Power of Steam and Water Engines: a Discourse on the Quality, Manufacture, and Choice of Cordage for Mine Service: together with a collection of essential Tables, Rules, and Illustrations, exclusively applicable to Mining Business. The whole introduced and exemplified in the most plain and practicable manner. By J. Budge. Second edition, considerably enlarged.

Preface.—Throughout this volume the benefit of the Practical Miner has been constantly kept in view; and although the Tables may be successfully used on other occasions, yet we have professedly the mining interest solely for our object.

It is hoped that the curious examiner will find no flagrant violation of the rules of composition or mathematical order; but to any who may be disposed to search for defects, we beg to state, that the work has been prosecuted and accomplished amidst numerous disadvantages, among which, the frequent interruptions arising from the almost incessant duties of a mining avocation have not been the least perplexing. But notwithstanding all this, we feel it incumbent on us to state, in defence of the calculations, that so far as Hutton's celebrated Logarithms, compared with those of other eminent authors, can be relied on as a foundation, together with the utmost care in, and repetition of, every single operation, supported by numerous subsequent proofs, both theoretical and practical, we are warranted in alleging our conviction, that the Tables may be received and applied to the most difficult and important operations in dialling, with the utmost confidence.

We now take a transient, but submissive leave of the Mine Agent, and respectfully address ourselves to persons in the capacity of Schoolmasters in mining districts.

To that respectable class of men this work is also recommended, as a fit subject for the study of those youths committed to their instruction, who appear designed for a mining occupation; and having ourselves had some years' experience in public teaching, we presume to declare our persuasion, that it is capable of being rendered extremely useful, by the prudent tuition of skilful preceptors. And why, we would inquire, should not the theory of the essential art of mining be taught in the seminaries of England, as well as in Mexico? (where, we understand, the colleges or schools of mines are among the most noble establishments of the empire;) but especially in Cornwall, where the principal support of the county depends on the prosperity of the mines, and where much of that prosperity depends on the judicious management of those persons to whom the superintendency thereof is committed.

In conclusion, we beg to remark, that we have generally used such terms as are common, and, in some cases, almost peculiar to mining business; believing that this phraseology will render the work far more intelligible and acceptable to the majority of those for whose use it is designed, than if we had confined ourselves to a precise mathematical mode of expression.

Contents. PART I.—Introduction; explanation and use of the tables; decimated arithmetic—reduction, addition, subtraction, multiplication, division; ali-

two persons can scarcely be found who precisely adopt the same method; consequently some plain scheme, founded on pure mathematical principles, is a great mining desideratum.

Aware of the opposition which is so apt to arise against all attempts at innovation of an old and established habit, (which, however faulty in itself, custom may have stamped with an imaginary perfection,) it may be necessary to make a few observations in support of this work, and endeavor to prove its advantages over all the preceding modes of performing a dialling operation in every respect.

quot parts of a fathom; preliminary chapter; definition of right-angled triangles; introductory examples; plane trigonometry—case 1, given the angle and hypothenuse to find the base and perpendicular by the first table—by construction; case 2, given the angle and perpendicular to find the base and hypothenuse by the second table—by construction; case 3, given the angle and base to find the hypothenuse and perpendicular by the third table—by construction; diagonal shafts; perpendicular ditto; cross cuts; when a lode has changed the underlay; when a lode has reversed the underlay; when a shaft has been sunk in error; to find the junction of lodes that underlie in the same direction; to find the junction of lodes that underlie toward each other; shafts and adits; drifts; drifts and intersections; slide—lode thrown up, lode thrown down; horizontal dialling; vertical dialling; miscellaneous examples; table I. hypothenuse radius; table II. perpendicular radius; table III. base radius; levelling; traverse dialling.

PART II.—Introduction; assay of silver ore, copper ore, lead ore, tin ore; method of extracting silver from copper ore; smelting silver ore; smelting lead and silver ore; silver assay table; method of computing the value of lead and silver ore; method of computing the value of copper ore; rule for discovering the power of steam engines; rule for discovering the power of water engines; table of the square inches in a cylinder; table of the weight of water in a pump, &c.; treatise on cordage; table showing the number of threads in a rope; table showing the length of rope to an hundred weight; table showing the weight of ropes 100 fathoms long; observations on capstan machinery.

SUPPLEMENT, OR THIRD PART.—Introduction; traverse dialling; table for converting angles into bearings; plans and sections of mines; miscellaneous; geology.—Explanation of Terms.

Explanation of the Diagrams. TABLE I.—In this scheme the hypothenuse is made radius, consequently the other sides are the sine and cosine of the included angle.

Corollary. Suppose one end of the line A B to remain at A while the other end B is moved round from *e* to *f*, then it is evident that the base C B will continue to increase, and the perpendicular B D to decrease, until the whole quadrant has been swept off.

At 45°, or the middle of the quadrant, the base and perpendicular are equal, and from that point to 90° the base will increase in the same ratio as the perpendicular decreased from 1° to 45°; hence the propriety of the arrangement of this table in counting the degrees backward from 45 to 90.

TABLE II.—Here the perpendicular is made radius, therefore the hypothenuse A C will be the secant, and the base B C the tangent of the angle A. On this principle it is clear that as the angle increases the base and hypothenuse will continue (throughout the whole quadrant) to increase in proportion.

TABLE III.—In this diagram the base is made radius, therefore by mathematical demonstration the perpendicular A C is the co-tangent, and the

Not many years ago, the customary way of ascertaining the perpendicular and horizontal lines corresponding with a diagonal shaft, was by the very uncertain, expensive, and tardy practice of dropping a plumb line from the back to the bottom, there fixing a sollar or platform, and repeating the process from the brace to the foot of the shaft; this usage is largely explained in "Pryce's Treatise on Mines and Mining," (a celebrated work, published by subscription, about the year 1776,) and therein described as the only system then known.

It is true this most objectionable measure is now exploded, but not without great reluctance by many of its old practitioners, who were long before they could be prevailed on to abandon it, notwithstanding its glaring inconveniences, accompanied with the loss of time, waste of property, and hazard of their lives.

By inserting this defectibility of our predecessors, we have no other design than of cautioning our mining countrymen to guard against the too prevalent propensity of rejecting any new system, merely because it is *new*, or its utility not discerned at first sight;

hypothenuse B C the co-secant, of the angle C; and here it will be plain, that as the angle C is increased, the hypothenuse and perpendicular will, proportionably, be diminished.

Illustration of the Characters.

\+ *plus* or *more*, the sign of addition; signifying that the numbers or quantities between which it is placed are to be added together.

− *minus*, or *less*, the sign of subtraction; denoting that the lesser of the two quantities between which it is placed is to be taken from the greater.

× *into*, the sign of multiplication; signifying that the quantities between which it is placed are to be multiplied together.

÷ *by*, the sign of division; signifying that the former of the two quantities between which it is placed is to be divided by the latter.

: *as*, or *to*, :: *so is*, the sign of an equality of ratios; denoting that the quantities between which they are placed are proportional to each other.

Thus, 2 : 3 :: 4 : 6, denotes that 2 is to 3 as 4 is to 6.

= *equal to*, the sign of equality; signifying that the quantities between which it is placed are equal to each other.

Thus, 6+4=10, shows that 6 added to 4 is equal to 10.

∠ *Angle.*

° *Degrees.*

' *Minutes.*

A given line is represented by a stroke or dash (|) as the base A B in the triangle in the last example of Plane Trigonometry, and a required line by a cipher (○), as in the legs of the same triangle.

Abbreviations.

Deg.	Degrees.	Tab.	Tabular.	Answr.	Answer.
Min.	Minutes.	Dec.	Decimals.	Dia.	Diameter.
Fath.	Fathoms.	N.	North.	Cwt.	Hundred-weight.
Ft.	Feet.	S.	South.	Qr.	Quarter.
In.	Inches.	E.	East.	Lbs.	Pounds.
Hyp.	Hypothenuse.'	W.	West.	Oz.	Ounces.
Perp.	Perpendicular.	Prob.	Problem.	Dwt.	Pennyweight.
Comp.	Complement.	Ex.	Example.	Grs.	Grains.

and to induce them to give the subject an impartial investigation, before they pass a conclusive judgment thereon.

The use of mathematical instruments is now partially known in the mining world; and, certainly, those agents who are well acquainted therewith, possess a decided advantage over others who are not; for, doubtless, this science has the pre-eminence, in a high degree, over every other method heretofore employed in dialling. But without intending to undervalue instrumental operation, we appeal to the experience of our scientific readers for support, in avouching that the process is ever liable to errors of considerable extent, and which are prone to slide in unaccountably: but it is a palpable fact, that in pointing or sweeping off the angles, an almost imperceptible deviation will create a serious departure from truth; and even in the course of bisecting, trisecting, inscribing, describing, and circumscribing; also in drawing parallels, raising or demitting perpendiculars, the operation, even with the greatest care, is exposed to considerable mistakes: and so sensible are all professional men of this defect, that instrumental operation is never resorted to, or relied on in any case where great accuracy is required. But when we reflect on the laborious duties of the practical mine agent, and how much these duties are calculated to disqualify him for performing a geometrical plan with that delicacy and precision, which the operation so indispensably demands, we then become established in our opinion of the necessity of a work of this kind, and of its superiority over every other system hitherto introduced in dialling.

Should any be yet disposed to advocate the existing practice, and to contend that it is fully adequate to the desired purpose, we beg permission to inquire of such persons, why it is that mistakes so commonly occur in sinking shafts and driving levels in most of our mines? That irreparable errors do frequently happen, is a truth too notorious for contradiction or dispute, and sometimes even under the superintendence of men, whose knowledge, circumspection, and experience, no one presumes to call in question; consequently a more convincing proof than this cannot be adduced of the fallibility of the best modern practice, and the necessity for the introduction of a more perfect system.

Should it be inquired wherein the merit of this work is considered to consist, we answer, First—*Accuracy;* and it will be discovered at a glance, that every operation of the principal tables is wrought out to five places of decimals, or the *ten thousandth part of an inch!* consequently we may affirm, without fear of confutation, that, in this property, we outvie every other system.

Secondly—*Plainness.* Of this quality our expert readers will be convinced at first sight, and will need no instruction for enabling them to apply the numbers readily; but we do not hesitate to say, that, by the help of the rules and examples, a common school-boy will find no insurmountable difficulty in solving the most abstruse problems relevant to dialling.

Thirdly—*Despatch.* To this desirable property no other system has an equal claim, or can, with any chance of success, enter into competition with our method; inasmuch as an answer, in most cases, may be obtained by the tables in less time than is necessary to make a preparation for performing the operation in any other way.

And now having briefly endeavored to set forth the work in a true light, we commit it to the judgment of a liberal and discerning people; and should it be instrumental in happily preventing the grievous errors which are so prevalent in mining operations (and which, we are bold to say, must, in the nature of things, continue to take place by the present day practice); or should it only help to relieve the minds of faithful superintendents from that painful anxiety and suspense which never fail to harass them during the progress of any considerable work, whereby a heavy responsibility rests on them for the accuracy of their dialling; or should it in any other way have the happy tendency of promoting the interest of mining, we shall not regret the labor, pain, expense, privation, trouble, and perplexity, it has cost us, even though we should never receive any other compensation.

EXPLANATION AND USE OF THE TABLES.

After so many preliminary observations, it will be necessary to say but little under this head, having already anticipated several things by way of introduction, which properly belong here.

The reader will observe that the work is composed of three distinct tables, for the obvious reason of making each side of the triangle radius; and certainly without such an arrangement it would have been incomplete.

In each case the radius, or given side, is one fathom, being the most convenient and familiar proportion that could have been introduced.

The principal calculations include every quarter, or fifteen minutes of a degree, and extend from 1 to 89 degrees, being sufficiently extensive and minute for mining purposes (the angle of any intermediate division not being distinguished or required); and here, it must be observed, that the divisions are expressed by 15, 30, and 45 minutes, which numbers represent $\frac{1}{4}$, $\frac{1}{2}$, and $\frac{3}{4}$ of a degree.

The first and most essential table is that wherein the hypothenuse, or longest side, is made radius, extending nearly throughout the quadrant, and every calculation wrought out to five decimal places of an inch, hereby giving a direct answer, in exact ratio to six feet of the given side, to the ten thousandth part of an inch.

Perhaps there may be a little difficulty at first, with persons unacquainted with mathematical order, in reading the first table. It must be remarked, that from 1° to 45°, or the middle of the quadrant, the degrees and parts are all on the left-hand side

descending, the base stands in the adjoining columns, and the perpendicular on the same line to the right; but beyond that point the degrees will be found on the right-hand side ascending, and then it must be specially noted that the perpendicular and base will have changed their positions, the base now standing on the right hand, and the perpendicular on the left hand, side.

In the second table the perpendicular is given and the angles extend to 60°. One valuable mining property of this table is, that it gives at sight the underlay in a fathom of every angle within the range of 60° including the divisions: so that if it is required to know the underlay in a fathom on any degree, or quarter of a degree, between 1 and 60, it will be immediately discovered by an inspection of the base in the column adjoining the given angle in this table.

In the third and last table the base is given, and as the application of this part of the work is not so general as the preceding, the angles have been given in degrees only: nevertheless this table is indispensable on some occasions, especially in levelling or driving adits. It will be found, like the second table, to extend from 1 to 60 degrees.

Having thus briefly stated the nature of the work under each separate head, it only remains for us, after a few general observations, to recommend the learner to the inspection of the following examples; for we believe that one practical operation will do more towards giving him a clear understanding or comprehension of the subject, than a volume written expressly thereon, confined to mere speculative description.

It may be remarked that, in almost every instance, the geometrical construction of the figure is introduced, with the calculation, which will tend to the satisfaction of the practitioner, and improvement of the beginner.

In conclusion we would remark, that the same attention must be paid in taking the angle, and measuring the given line, when these tables are used, as if the operation was performed any other way.

It is a common practice in mining to take the angle of underlaying shafts with the cover of the dial and a plumb-line; and in short drafts, with great care, this method may answer well enough: but when any very important work is to be performed, we would strongly recommend the application of a more perfect instrument for ascertaining the angle; for it is well known, that if this part of the process should not be correct, the result of the whole work must be erroneous as a matter of course; and indeed it is next to impossible to distinguish the minutia of an angle, with any tolerable degree of certainty, by the foregoing method. There doubtless are instruments much better adapted to the work, both for speed and accuracy, than the dial; and it is matter of surprise that they have not been more generally introduced in our mines:

of these instruments the Theodolite certainly stands unrivalled for taking both horizontal and vertical angles.

It is not our design to enter into controversy on this subject; those who imagine the sextant or quadrant graduated on the cover of the dial well calculated for the purpose, let them continue to use it; only we would especially note, that should an error ensue, it ought by all means to be attributed to the real cause, and to that only: for, as in all trigonometrical questions, the angle and side are always given to find the other parts of the triangle, consequently the sum of the one and length of the other are presupposed to have been correctly ascertained, previous to the commencement of any other operation.

Finally, for the learner's sake, we observe, that as the tables exhibit only the relative proportions to the radius of one fathom, or six feet, and are wrought out to five places of decimals to an inch, it becomes necessary that every one who would use this work successfully should have some knowledge of decimated arithmetic; because he will have, in most cases, to multiply for the whole numbers, and take parts for the fraction of the fathom. For example: suppose the given side to be the hypothenuse, measuring 16 fathoms, 3 feet, and 6 inches, he will then have to take out the numbers opposite the given angle in the tables, and multiply them by 16, for the base and perpendicular respectively, then divide half the tabular measure for the 3 feet, and one sixth of the remainder for the 6 inches, and add them together for the sum of the required sides of the triangle. We have therefore introduced the following rules and examples in decimals, which are sufficient to enable any one, hitherto unacquainted with this branch of arithmetic, to use the tables with the greatest facility.

REDUCTION OF DECIMALS.

Rule.—Multiply the decimal by the number of parts in the next less denomination, and cut off as many places to the right hand as there are places in the given decimals.

EXAMPLE.

What is the value of ·75014 of a fathom?

6

4·50084

12

6·01008

ft. in.

Answer 4 6·01008

What is the value of ·93862 of a yard?

3

2·81586

12

9·79032

ft. in.

Answer 2 9·79032

What is the value of ·27734 of a foot?
12

3·32808

in.
Answer 3·32808

fath. ft. in.
Reduce 5 4 6·32 to feet, inches, and decimals.
6

— in
Answer 34 6·32

(To be continued.)

JOURNAL OF MINING LAWS AND REGULATIONS.

INTERESTING TO TRUSTEES OF CORPORATIONS.

David Gwynne vs. *Thomas B. Kettel.*—BRADY, J.—The liability of the defendant depends upon the construction to be given to the 12th section of the act to authorize the formation of corporations for manufacturing, mining, mechanical or chemical purposes. (Sessions Laws, 1848, p. 54.) The defendant was one of the trustees named in the original certificate required by the first section of the act referred to, and which certificate was filed in the office of the Clerk of the City and County of New-York, on the 1st of June, 1853, and the duplicate thereof filed in the office of the Secretary of State of the State of New York, some time during said month. By section 2d of the act, the persons who signed the same and their successors when the certificate was filed, became a body politic and corporate, with all the powers conferred by the statute. The 12th section of the act provides that "Every such company shall annually, within 20 days from the first day of January, make a report which shall be signed by the President and a majority of the trustees," &c.; and also provides that "if any of the said companies shall fail so to do, all the trustees of the company shall be jointly and severally liable for all the debts of the company then existing and for all that shall be contracted *before such report shall be made.*" The Ohio River Land and Marble Company, created by the certificate aforesaid, and of which the defendant was one of the original trustees, omitted, within 20 days from the first day of January, 1854, *or at any time afterwards*, to make the report required by the last-mentioned section, and the plaintiffs insist that the defendant became therefore personally responsible to them by reason of such omission. If the Company was by the statute bound to make the report called for by the 12th section before the expiration of a year from the time of their formation, and within 20 days after the first of January ensuing their formation without regard to the time of their creation, then I think the allegations in the complaint are sufficient, and that the demurrer was not well interposed. The word "annually" in the 12th section must be construed to mean the same as if written *every year*, and to relate to the first day of the statute year, (2d Rev. Stat. p. 11, 4th ed.,) and not to the annual or yearly *existence* of the Company. Any other construction would defeat the object of the statute to secure a yearly statement of the condition of companies formed under it, inasmuch as a company erected in February of one year would not be bound to report until the second January ensuing after such creation, and for the reason that the report is to be made within 20 days after the first January, and not within 20 days after the annual existence, and on such construction would not be due prior to the time first named.

The allegation that the defendant and others named in the complaint signed the certificate by which they declared that the concerns of the first

year were to be managed by them, and that those persons and the defendant were the trustees at the time of the performance of the labor *in pursuance of the contract* set out, coupled with the fact that the first year had not expired when the cause of action accrued against the Company, namely, March, 1854, is a sufficient statement of the fact that the defendant was a trustee at the time such indebtedness so accrued. The word year used in the act means three hundred and sixty-five days, (2 R. S. p. 1, 4th ed.) In all other respects the complaint seems to be unquestionable, and the demurrer must be overruled and judgment given for the plaintiff, with liberty, however, to the defendant to answer within 20 days, on payment of the costs of the demurrer.

COMMERCIAL ASPECT OF THE MINING INTEREST.

MINING STOCKS IN BOSTON.

BOSTON, March 1, 1857.

Mining Stocks have generally been dull for a month past, with but moderate transactions, and lower, excepting Minnesota, which is sustained by the expected dividend for the profits of the past year, and besides its real worth is considered fully up to the present market value. Some of the lower-priced kinds have been depressed by the assessments which have come out very freely of late. The month of March seems to be very prolific of this sort of annoyances to shareholders, as will be seen by the following list of maturing assessments:

Companies.	Amount.	When Payable.
Flint Steel River	One Dollar per Share.	Payable March 10th
Superior	" "	" " "
Phœnix	" "	" " 11th
Isle Royale	Two Dollars per Share.	" " 23d
Quincy	One Dollar per Share.	" " "
Pewabic	" "	" " 25th

Isle Royale fell from 7 to 4⅜ on the announcement of the $2 assessment, which took everybody, but the "knowing ones," by surprise, as it had been frequently stated by the managers that further assessments would *not* be necessary; and those who even intimated such a thing were hardly treated with respect. The concern has proved a complete failure, so far as the interests of the stockholders are concerned, for the last year's operations did not pay expenses. One year ago we were told that the product of 1856 would certainly reach 300 tons, and that a *dividend* of not less than $2 per share was a *sure thing*. The actual results were the shipment of only about 230 tons, and the dividend turned into $2 *assessment*, making a difference of $4 to each shareholder, beside a depreciation in his stock from $19 (July, 1856) to $5, the present market value. We are still told by friends of the concern that a dividend will be forthcoming "next spring," but it is much more likely to result in an assessment as heretofore.

Pewabic also felt the effect of an assessment, and declined to 3¾; but has

since rallied about $1 per share. This mine produced a handsome amount of copper last season (over 100 tons) for its first year, and promises to yield at least 200 tons this season. A disputed claim of some $11,000 with the Great Western Insurance Company of New York, has, for the present, crippled the Company's finances, and rendered the call on the shareholders necessary. The course of the Great Western Company is severely censured here, as it is believed their refusal to pay over is a mere quibble in hopes to get rid of the loss. Other similar risks on the same vessel have been promptly paid by Companies in this city and in New York. We understand the Company have sued the Great Western office for the above amount, and their case would seem a very clear one.

Minnesota has further advanced, and now 116 is bid, 120 being the lowest asked. The advance in this stock has been remarkable since the shares were increased to 20,000. It then (July, 1855) sold at $30 per share, and $10 per share dividend has been since paid. Another dividend of $15 per share will soon be paid (see below), and even larger ones are looked for in the future. The product for January was 156½ tons.

Pittsburg (Cliff) has been dull, and sales could not now be effected above $235, a decline of about $10 per share. The product for January was 186 tons. We have before mentioned that it was contemplated to increase the number of shares in this Company from 6,000 to 20,000, but this has been frustrated by the refusal of Michigan Legislature to pass the necessary act. This Company cannot, as the Minnesota did, reorganize under the General Mining Law of Michigan, as that act restricts any one Company from holding over 3,000 acres of land, and the Pittsburg property comprises, we believe, some 5,000 acres. Besides this, their special charter conveys some other privileges they do not wish to relinquish. It was proposed, accordingly, to pass a General Act to meet the cases of the Pittsburg, National, North American, Isle Royale, Quincy, and perhaps other Companies, with less than 20,000 shares, enabling them to increase to that number, and thus all stand on the same basis. This, however, failed in the Legislature, and must now lie over another year at least.

National has been up to $50 since our last, and the shares could not be had much if any below that figure now. At present, however, the stock is very inactive. The product for January was 20 tons, which shows a handsome increase, and speaks well for one of the worst of the winter months. The mine promises to prove a very valuable one. *North American* holds steady at about 25, with transactions only to a small extent. We hear nothing new from the mine, but believe its present condition is highly flattering. *Rockland* has receded from the extreme quotation of 40, and private sales have been made at about 35, which is now the bidding price, and no shares offered under 40 again. The product for January was 23 tons.

Copper Falls is dull at about 4, and not a sale for more than a month. Accounts from the mine are said to be favorable, but the stock does not move; and we fear that further assessments will be necessary before the concern is "out of the woods." An important and valuable feature in the management of this mine is the remarkable per centage to which the stamp stuff

is dressed. The product of November last was dressed to 99, 95 and 52 per cent., respectively, for Nos. 1 and 2—3—4; something we venture to say has

BOSTON MINING SHARE LIST.

Fluctuations for February, 1857, in fifteen different Copper Mining Stocks, sold at the Boston Brokers' Board, showing their highest and lowest points, and the date, with the Market Value at the close of the Month, Gain or Loss for the Month and Number of Shares sold in each.

MINING STOCKS, BOSTON	Location of Office	Nominal Capital	Nominal Par.	Number of Shares	Paid in per Share	Total paid in	Highest Sales.	Day of month.	Lowest Sales.	Day of month.	Value Feb. 28	From Jan. 31 Gain.	From Jan. 31 Loss.	Shares sold in Feb.	Shares sold in Jan.
Copper Falls	Boston	$500,000	25	20,000	$20,00	$400,000	—	—	—	—	4	—	1¼	no sale	85
Central	Pittsburg, Pa.	500,000	25	20,000	0,85	17,000	4	—	—	—	4	—	1	300	no sale
Flint Steel River	New York	500,000	25	20,000	3,50	70,000	3	7	† 2½	27	2½	—	2	25	no sale
Huron	Boston	500,000	25	20,000	4,50	90,000	—	—	—	—	2	—	¼	no sale	no sale
Isle Royale	Boston	—	—	12,000	14,00	168,000	8	2	4¼	20	4¼	—	3¼	1976	1891
Minnesota	New York	1,000,000	50	20,000	3,20	66,000	110	14	110	14	112	2	—	24	67
National	Pittsburg, Pa.	250,000	25	10,000	11,00	110,000	50	10	49	12	45	0	0	9	no sale
North American	Pittsburg, Pa.	*10,000	30	*10,000	23,50	211,500	24	7	24	7	25	—	5	2	no sale
Norwich	New York	500,000	25	20,000	10,00	200,000	1	21	1	21	1	—	1½	350	no sale
Pewabic	Boston	500,000	25	20,000	1,75	35,000	5½	2	3½	28	3½	—	1½	534	558
Pittsburg (Cliff)	Pittsburg, Pa.	—	—	6,000	18,50	110,905	245	3	240	24	237	0	0	18	1
Phœnix	Boston	300,000	30	10,000	9,00	90,000	—	—	—	—	1	—	1	no sale	no sale
Quincy	Detroit, Mich.	—	—	8,000	6,50	52,000	—	—	—	—	8¼	0	0	no sale	no sale
Rockland	New York	500,000	25	20,000	2,00	40,000	40	9	40	12	35	—	3	39	20
Superior	New York	500,000	25	20,000	2,00	20,000	† 8½	17	8½	9	† 8	—	1½	160	200

* 1000 shares of the North American are not assessable. † Flint Steel and Superior assessment paid $1 each.

never before been equalled, or even approached, by any other mine at the Lake. We believe it is contemplated to sell the No. 1 and 2 stamp stuff without smelting, thus saving considerable expense to the Company.

Superior and *Flint Steel* are both dull and heavy, with few buyers. T assessment on the Superior is the first for mining purposes, the $1 previou laid being for the purchase of valuable territory adjoining. The pres amount paid in on the *Pewabic* is $1 75 per share, but of this only 25 has been levied since the management of the Company was removed Boston in the Fall of 1855. The $1 50 per share ($30,000) was expen previously, with inadequate returns. *Norwich* has fallen to $1 per sh through fear of an assessment, which will probably be decided at the ann meeting on the 18th instant. *Toltec* has almost faded out of sight, and o 12,000 shares of the stock are to be sold at auction April 9, for the non-p ment of $1 per share recently assessed. The *Native* Company have asses six cents per share (on $600 or 10,000 shares), due April 8, for the purpos paying up a small amount of past-due taxes, and other arrearages.

Minnesota Dividend. We learn that the Directors will, at the annual meeti March 11, declare a dividend of $15 per share, as the profits of the year 18 and reserve some $3 per share additional. This dividend is payable, $7½ A 1, and $7½ on the first of November next. It is to be made up to holder stock March 25, who will be entitled to the *whole* $15, and the books for tr fers will remain closed until April 2. We are officially informed that h after regular semi-annnal dividends will be made, May 1 and November which is most decidedly the best plan, and is in accordance with the un mous wishes of the Boston stockholders, as expressed in our Novem number. We think too, that it will be much to the advantage of the C pany in every respect.

Mining Machinery at the Mines of Lake Superior, January 1, 1857.

The following statement of the machinery used at the mines, and also heads of stamps, will be of interest, especially for reference hereafter.

Keweenaw Point.	Engines.	Horse Power.	Heads of Star
Cliff	6	209½	24
Copper Falls	5	110	50
Keweenaw	1	20	16
North American	6	166½	20
North West	2	63	16
North Western	2	63	16
Phœnix	1	5½	12
Summit	2	14	8
Star	1	—	—
	26	651½	162
Ontonagon.			
Forest	3	76	24
Ohio Trap Rock	1	26	24
Minnesota	4	182	12
Norwich	1	21	16
Ridge	2	49	8
Rockland	1	28	12
Toltec	3	98	32
Windsor	1	21	12
	16	501	140
Portage Lake.			
Huron	1	8	—
Isle Royale	3	91½	36
Portage	2	40	16
	6	139½	52

The aggregate cost of the steam engines is estimated at $308,700. Of the twenty-six at Keweenaw Point, three are portable engines. At Copper Falls the stamp heads are put down as fifty, while two of them (Ball's machinery) are actually equal to fifty of the old style. Each stamp head should pulverize 2000 lbs. of rock in 24 hours. So that reckoning Ball's stamps equal to 50 heads, the aggregate machinery at the Lake should crush 392 tons of 2000 lbs. per diem, equal, at 1½ per cent., to nearly 6 tons of fine copper. The Phœnix Co's. stamps are run by water power.

COALS AND COLLIERIES.

ANTHRACITE COAL TRADE FOR 1857.

	Tons.
Shipments by Reading Railroad, to March 12th	367,331 09
Same time last year	311,579 10
Increase	55,751 19

LEHIGH COAL TRADE FOR 1857.

Quantity of coal sent by railroad, to March 7th:

William Milnes & Co.	18,234 05
Ratcliff & Johnsons	11,209 00
Packer, Carter & Co.	12 224 00
New York & Lehigh	7,593 18
Sharpe, Leisenring & Co.	11,440 00
German Pennsylvania Co.	1,100 14
Dobbin & Dehaven	233 13
Hazleton	1,306 15
Total	63,342 06

SCRANTON COAL TRADE FOR 1857.

Shipments for the month of February:

North	Month, 10,480 tons		21,315
South	" 19,114 "		35,069
	29,594	Total	56,384

LYKENS' VALLEY COAL TRADE.

Lykens' Valley Coal Co.	4,797
Short Mountain Co.	2,589
Total	7,386

SHIPMENTS FROM ELIZABETHPORT.

The amount of coal shipped from Elizabethport during the year 1856, was as follows:

Scranton coal	72,908
Lehigh Valley coal	17,000

CUMBERLAND COAL TRADE TO MARCH 1ST.

By Cumberland Coal and Iron Co's. Railroad.

Cumberland Coal Co.	13,858 11
Percy & Co.	000 00
Ætna Co.	1,888 16
Total	15,747 07

By Cumberland and Pennsylvania Railroad.

Frostburg Coal Co.	8,015
Borden Mining Co.	3,461
Allegany Coal Co.	2,691
Wellersburg Coal Co.	46
Carbon Hill Coal Co.	
Union Coal Co.	
Total	59,850

By George's Creek Railroad.

George's Creek Co.	9,635 00
Swanton Co.	2,686 08
American Co.	8,121 00
Franklin Coal Co.	4,328 11
Lonaconing Co.	55 09
Transportation Co.	
Pickell Coal Co.	2,039 01
C. E. Detmold	1,218 05
Preston Coal Co.	
Total	28,078 14

By Hampshire Coal and Iron Co's. Railroad.

Hampshire Co.	6,810 13

OHIO COAL TRADE.

The quantity of coal mined in the interior of Ohio is constantly increasing, and indeed the consumption is also. At present this trade attracts much of the public attention; and we give, as nearly as we can determine it from the Report of the Board of Public Works, the amount of coal transported on the canals, and the places where to and from:

	Shipped from.—Bushels.	Received at.—Bushels.
Cleveland		5,210,270
Akron	4,703,640	
Dover	397,771	
Roscoe	246,390	
Newark	31,000	437,700
Carroll	496,459	22,800
Columbus		418,865
Circleville		89,054
Chillicothe	5,761	311,162
Portsmouth	94,561	
Logan	701,347	
McConnellsville	158,517	154,058
Harmer	15,951	10,190
Cincinnati	277,891	
Hamilton		62,628
Middleton		37,635
Dayton		83,414
St. Mary's		4,900
Piqua		2 900
Defiance		10,468
Toledo	16,662	
Aggregate	7,135,960	6,806,064

This does not represent the coal trade of Ohio, but only that part which is carried on canals. It will be seen that the greater part of the coal is shipped on the Ohio canal, from Summit county, and on the Hocking canal.—*Cincinnati Railroad Record.*

NEW COAL FIELD.

A report has reached us that indications of coal have been found in the vicinity of Menominee River, but as yet nothing of a very definite or certain character has reached us. Should there be an abundance of coal found there, it changes entirely the complexion of the iron business in this vicinity, and we shall look for further development with interest.—*Lake Superior Journal.*

THE BITUMINOUS COAL TRADE.

The development of the Cumberland coal trade is a subject of vital interest to our community. The Baltimore and Ohio Railroad last year, according to its October annual report, brought down about 450,000 tons, being only about the same quantity carried during the previous year. The reasons assigned for this comparatively limited business were that the company could not devote its cars and engines to the coal trade while merchandise was offering, and especially because of the further alleged fact that the coal did not sufficiently pay the company at the rates of freight then charged. The charges were accordingly advanced by fifty cents per ton from all points, after strenuous opposition, to take effect on the first of October, the beginning of the present fiscal year. This measure was accompanied by such action on the part of the road as would tend to increase the trade, by the addition of facilities for the more enlarged transportation of coal to market, the chief reliance that the coal interest were supposed to require to properly develope their operations. It was feared, however, that under the rise in freight the business would not thrive, but that it must necessarily fall off to a greater or less extent. By inquiry we find that for the five months just expired since first of October, the quantity of coal brought to Baltimore has been 171,309 tons, to 121,472 tons for corresponding period of previous year —showing an increase in the aggregate of 49,939, or say 50,000 tons. This increase has been quite regular, as follows: 3,365 for October, 1,353 for November, 7,634 for December, 16,569 for January, and 21,016 for February. At the same ratio the year's increase would be about 175,000 tons, making the aggregate over 600,000 tons brought to the city of Baltimore for the present fiscal year of the road. We are told, too, that the additional facilities promised for the transportation of coal are hardly yet prepared, the engines contracted for not being yet delivered for use. With this further advantage afforded by the company, the amount of coal brought down may be even more increased than the figures already given would indicate, as we are assured that the extent of this valuable trade is only limited to the power of the transportation lines in bringing it to market. As an evidence of this, it is understood that one alone of the many coal mining companies, whose trade heretofore has been comparatively trifling, now offers to bind itself in ample security to pay the freight on 125,000 tons in the current year, as a means of inducing the railroad to bring that quantity to meet its contemplated contracts.—*Balt. Sun.*

KENTUCKY COAL MINING COMPANY.

The lands of this Company lie on the Kentucky side of the Ohio river, below and contiguous to the city of Henderson, one hundred and ninety miles above Cairo. These lands comprise an area of 1,830 acres, or about three square miles. Their frontage on the Ohio river is two miles.

The following statement is made by this Company relative to the quantity of their coal:

"Admonished by the failure of other companies, arising from the neglect of proper precaution in testing the quality of their coal before embarking their capital in mining it, we had ours analyzed by Professor F. A. Genth, of Philadelphia, one of the most accomplished mineralogists and analysts in the United States. His result, which is given further on, will be found entirely satisfactory; and we have recently received the most gratifying confirmation of it from actual use on a large scale.

A considerable quantity of it has been raised by our neighbors, the 'Henderson Coal Company,' and has been pronounced by the steamboat captains, after a full trial, to be unsurpassed by any that they have used from either the Lower Ohio or from Pittsburg.

Specimens of it may be seen at the Company's office. It is compact in structure, and therefore subject to comparatively little waste in mining.

It is well known that the coals from any coal-field may vary much in quality, depending chiefly on the particular seam or vein from which it may be extracted.

Our Pennsylvania anthracites afford abundant evidence of this fact. It is, however, more strikingly exemplified in the bituminous coal-fields, where a much wider disparity is found to exist among the coals of adjacent veins.

Many bituminous coals, although of a firm consistency when first mined, soon begin to disintegrate and fall to pieces on exposure to atmospheric influence. To such an extent does this injurious property characterize some coals, that they will not bear the handling to which they must be subjected in transportation, and consequently they are scarcely entitled to rank among commercial coals.

	Name of Analyst.	Bituminous and other Volatile Matter.	Carbon.	Ashes.
Callaway (Cannel co.) mean of two trials	Prof. D. D. Owen	39·45	31·80	28·75*
The same, analyzed for the Company by	Profs. Booth & Boye	40·05	46·82	13·13*
Pomeroy, 208 miles below Pittsburg	Prof. D. D. Owen	39·29	47·72	12·99
Wheeling, 94 miles below Pittsburg	Prof. W. R. Johnson	44·04	52·03	3·93
Youghiogheny (or best Pittsburg)	Prof. D. D. Owen	36·46	60·14	3·40
Henderson (our coal)	Prof. F. A. Genth	42·56	54·29	3·15
Breckenridge	Prof. B. Silliman	64·29	27·16	8·47
Hawesville	Prof. D. D. Owen	47·00	46·00	7·00

* We are at a loss how to account or the singular discrepancy in these two analyses, unless by supposing the specimens to have been taken from different seams. The analysts in both cases are of the highest rank.

Our coal is not in the slightest degree liable to this objection. Some of it has been exposed on the ground to the alternate action of rain, frost, heat and cold, for eighteen months, without manifesting any tendency to disintegrate.

* * * * *

Therefore, with a view of presenting a comparison between our coal and some others, the names of which are well known in western commerce, we give some results of analyses by competent chemists.

Thus, of this list, it appears that in point of carbon we rank next to the best Youghiogheny coal, and the analyses indicate a slight superiority over even it in regard to ashes. Trifling differences of but small percentage, however, do not in reality affect the market value of fair coals for ordinary purposes. Neither the cook nor the fireman of an engine trouble his head about the precise chemical composition of his coal; he cares only that it should burn well, and raise steam quickly. Besides, it is a pretty generally acknowledged fact that at the present day everybody's coal is a little better than anybody else's. Analyses both by Professor Owen and by Professor Genth show that a somewhat higher per centage of carbon exists in the coals of some seams in our vicinity than in our own; equalling, indeed, the Youghiogheny in this respect. This remark applies both to the Bell seam and to some of the seams on the Saline estate. The various seams in our region will therefore stand in the market as do the anthracites of Pennsylvania. One purchaser will prefer that containing the most carbon, and another that with the most bitumen; while the mass of purchasers will buy without reference to either, being content to get a good coal at a fair price.

We shall, therefore, institute no invidious comparisons between our coal and that of our neighbors of the same region, but shall content ourselves by referring to the above table."

IMPROVEMENT IN COKING.

An improved coking kiln has been contrived by Mr. Ebenezer Rogers, of Abercarn, Wales. In describing it, the inventor says:

Since the introduction of coke ovens, many improvements have been made in their construction; but the expense attending their erection and maintenance, and a consideration of the theory of the process of coking, have led the author to the invention of a plan, by which, instead of the small closed ovens, a long kiln of large dimensions, and open at the top, is employed. The kiln consists of two long side walls, containing a number of horizontal and vertical flues, the latter acting as chimneys. The ends of the kiln are left open while it is being filled, and are built up as soon as it is ready for firing. In filling in the coal, passages are left through the mass from one side to the other, connecting the opposite flues in the side wall of the kiln. The fire is lighted at the bottom of the kiln, through the holes in the side walls, and is spread uniformly through the coal by opening the flues in one side, and chimneys in the other, which causes a draught through from one side to the other; the draught is reversed alternately, until the whole mass is fired at the bottom. All the flues are then closed, and all the chimneys opened, and a current of air is drawn down from the open surface, through the whole mass of coal, to the burning portion below. The coking process commences at the bottom, gradually ascending till it reaches the surface, when the operation is completed. The coke is then drawn, and the kiln charged again with fresh coal; the wagons for carrying away the coke are run into the kiln on a temporary railway laid through it, and the coal for the next charge is then tipped in from the top. These kilns contain as much as 150 tons each, and cost less than the ordinary coke ovens containing only 6 tons each, the result being a very great saving in original outlay, and in the space required for producing a large supply of coke; whilst, from the great simplicity of their construction, the cost of repairs is very small. Several of these kilns are already in use at some of the largest iron works, and an increased yield and superior quality of coke are obtained from them.

ON THE MODE OF TUBBING SHAFTS IN COAL MINES.

A tub is a cylinder put into a shaft, for the purpose of beating out the water, in order that it should rise to a level. The system used in the coal districts of Mons and Charleroi, adopted by the Belgians, has a great superiority over that carried into effect by the French coal mining engineers. Tubbing formed of iron first came into use during the latter part of the preceding century; it was then tried with wrought iron, fixed in by rivets, but this, after several trials, and a considerable period, was not found to be so advantageous. Cylinders were then employed, and their introduction dated about the year 1795. Cast-iron was generally used now—he might say almost invariably; it was always to be desired, if these could be sunk to a bed offering a very secure foundation. Where they were liable to be subject to floods, great circumspection and quickness had to be exercised. In the method of casting cylinders in Belgium, in some instances, in order to strenghen the wedging curb, it has been found requisite to avail themselves of brickwork; deal wedges were used, and when these were no longer of service, those of oak, or some other hard wood, were substituted. As many as 25,000 of these wedges would be employed in a pit of comparatively small diameter. In placing the cylinders, it was an object of paramount necessity that the strength as well as the height should be calculated according to the pressure they would have to sustain. In some cases the tubbing has to be strengthened by brackets placed at intervals, and they should always be cautious not to sacrifice security to weight—the extra expense of cast-iron, where safety was to be considered, being of little or no importance, that material not being of an expensive nature. In some cases the rings are supported by wedges. At present, at Dunkinfield, near Manchester, they are tubbing a shaft, which was a good practical example. On occasions it was necessary that modifications should be introduced, and especially where pump and pit work were required; these did not, however, often occur, but, when it was the case, plates of a peculiar

construction were requisite. In some instances, where furnaces were used for the purpose of ventilation, the sulphurous exhalations very much corroded the tubbing, and this had often to be renewed at a considerable expense. In several cases this has been obviated by lining the shaft with deal boards of about 1½ inches thick. Some good examples in tubbing by masonry can be seen in the Ruhr district, Westphalia. Tubbing properly depended on the sinking of shafts through running ground, by forcing down cast-iron cylinders by weights. In France, in the coal districts near the River Loire, in the vicinity of that stream the soil was principally through sand and gravel, and it had been for a considerable period a great inconvenience and expensive to sink any shafts there. By the introduction of compressed air, a mining engineer of the name of Tricer had overcome these obstacles, and in that neighborhood, by the adoption of his plan, about 20 shafts had been sunk under circumstances of almost unparalleled difficulty. In Belgium this plan had not been found so successful. It had been thought at first that this mode of working would be prejudicial to the health of the men; it was found that this was not the case, but that they required to be better fed. The candles likewise burnt faster there; and, on one occasion, when an accident had occurred through a man falling asleep, his clothes had quickly been burnt, being ignited by his candle. There was no doubt but that this method of working by compressed air required great caution and good management. At the Great Albert Bridge, over the River Tamar, Great Britain, they had tried (when sinking the shaft there, to arrive at a secure foundation) compressed air, and although this was not received at first without some prejudice, yet eventually a good foundation had been arrived at.

COAL ON THE MONONGAHELA.

The Pittsburg Post, speaking of the Monongahela Slackwater improvement, says:

"On account of the low stage of water for six months past, this invaluable improvement has been comparatively useless—at least for the transportation of coal—and, as a consequence, hundreds of thousands down the Ohio have been suffering the pangs of fuel famine. But their suffering, if not at an end, will be so in a few days. There cannot be less than from eight to ten millions of bushels of bituminous ready mined along the Monongahela Slackwater, most of which will find its way to market before the ground hog again comes out of his hole—if he really did go back again, after seeing his shadow last Candlemas Day, which many incredulous people affect not to believe."

A NEW COAL BURNING LOCOMOTIVE.

Richard Norris & Son have just completed at their extensive locomotive works on Bush Hill, one of the most substantial and beautiful passenger locomotives ever built in our city. It is built with Phleger's patent boiler and furnace, for the use of anthracite or bituminous coal, and is intended for the Lackawanna and Bloomsburg (six feet gauge) Railroad. The entire length of locomotive, from bumper to rear end, is 31 feet; boiler 20 feet long and 40 inches in diameter, having 194 tubes, and containing about 1,300 feet of heating surface. By a recent improvement made by Mr. Phleger, the smoke and gases from the coal are consumed, and nothing issues from the chimney except the exhaust steam. This important end is accomplished by the heat reverberating over a combination of fire bridges in the furnace, which also prevent the burning of the end of the tubes in the boiler. The grate bars in the furnace are tubular, and, when in use, filled with water, thus preventing them from burning out, as in ordinary locomotives, saving a great deal of trouble and expense in their frequent replacement.

Another improvement consists in the arrangement of the fire pan or ash pit, by which the firemen can clean it while the train is in motion, and is

also kept from injury when passing through snow or water. The engineer's house on the locomotive is 10 feet long and 8 feet wide, built in the Gothic style, of oak and mahogany, handsomely painted, and adorned on one side with a well executed likeness of Mr. Phleger, the inventor of the boiler, and on the other with a boy sleeping upon the bank of a stream while a large dog stands by his side watching. The engineer does not stand upon the platform in front of the furnace, but on the side, elevated some two or three feet above, giving him an unobstructed view of the road. The engine will weigh about 27 tons, and the entire work upon it reflects great credit upon the Messrs. Norris, as well as upon the liberality of the company ordering it, and who are desirous of testing so valuable an improvement in the construction of locomotives, which will retain the speed and reduce the cost of running them.

Last fall, Norris & Son constructed a locomotive called the "Eora Nash," upon the same principle, for the Schuylkill and Lehigh Valley Railroad, which was tried on the Pennsylvania State Road, previous to its delivery, much to the satisfaction of Mr. Baker, the Superintendent. The Superintendent of the Schuylkill and Lehigh Valley Road states, in reference to the locomotive, after a full trial, that the Phleger boiler surpasses all other boilers he has had any experience with, for generating steam with anthracite coal for fuel. He had passed over the road several times upon the engine, with a train of 85 coal cars, and invariably found that she made more steam than was necessary to haul the train.

On one of the down trains, half the distance was travelled with the furnace door open, and on one occasion the engineer ran the steam down to 80 pounds. He then closed the furnace doors, and in three minutes it rose to 110 pounds. The Superintendent further says that he is satisfied that the consumption of fuel will be at least 50 per cent. less than any other boiler now in use. The large amount of fire surface in the boiler renders it entirely unnecessary to keep up such an intense heat as must be done in the ordinarily constructed boiler. There is no coal thrown from the stack, and very little deposited in the smoke arch.

The engine now at Norris's is highly ornamented; the chimney is of Russia iron, with spun brass bands; the steam dome, cylinders and steam chests are all covered with brass, highly polished. This locomotive, it is expected, will be removed from the shop to-day, and pass over the North Pennsylvania Railroad.—*Public Ledger.*

MICHIGAN COAL—ITS ANALYSIS AND VALUE FOR GAS.

Prof. S. H. Douglas, of the State University, communicates to the *Peninsular Journal of Medicine* for March, the subjoined interesting article concerning our Michigan coal, and its value in making gas. It will be read with much attention:

As wood and oil advance in price, whatever relates to the coal of Michigan assumes an increased importance to the people of our State. Having recently made an analysis of coal from the coal bed of Mr. Hayden, near Jackson, I deem it a matter of sufficient importance to make the result public. The analysis had particular reference to the value of the coal for the manufacture of coal gas.

The coal was of the bituminous variety, having a jet black color, and slaty structure. It was readily ignited, burning with a dull flame and much smoke, the fragments comminuting more or less by the heat. It had a specific gravity of about 1.25.

100 parts gave:

Volatile Matter	50·780
Sulphur	4·028
Iron	4·408
Ash	8·400
Carbon (not volatilized)	41·600

The value of coal for the manufacture of gas is usually estimated by the

amount of volatile matter which it yields at a full red heat. The following list of English coals, taken from the best authorities, are given in the order of their gas-producing properties, as determined by actual trial, for the purpose of comparison:

	Volatile Matter.	Ash.	Sulphur.
Boghead	68·4	22·8	1·06
New Brunswick Cannel	66·3	·6	·14
Kirknep	60	13·5	2·80
Staffordshire Cannel	50	2·9	2·60
Arniston	45·8	4·2	3·40
Silkstone, (Yorkshire)	38	2·6	2·30
Wigan, (Lancashire)	37	3	2·40
Ramsey, (Newcastle)	36·8	6·6	2·50
Nielsea, (Somerset)	34·9	3	5·70
Coal Pit Heath	30·1	5·8	8·20

It is apparent from the above that the amount of volatile matter in the coal holds a fixed relation to its gas-producing properties.

The following table, compiled from Prof. Johnson's work, will show the volatile matter in the several varieties of American coals. The sulphur is not given in these analyses, but there is no reason to believe that it will be very much less than the average of any coals:

	Volatile Matter.	Ash.
Beaver Meadow, Pa.	3·30	7·11
Peach Mountain, Pa.	3·07	4·41
Lehigh, Pa.	5·28	5·56
Cumberland, Md.	14·87	14·98
Blossburg, Pa.	14·78	10·77
Midlothian, Va.	27·28	10·47
Cannelton, Ind.	33·99	4·97
Pittsburg, Pa.	36·78	7·07
Jackson (by Prof. D.)	50·78	8·40

From the above it will be apparent that the coal of Michigan for the manufacture of gas is nearly equal to the best English coals, and quite superior to any of the American coals around. I have not access to analyses of the Ohio coals, and am not aware that any have been made.

IRON AND ZINC.

IRON MINES OF MORRIS COUNTY.

For the Mining Magazine.

Every year of the existence of our country, iron and the iron interest seems to be gathering greater importance. Fifteen, years since, the iron ore deposits of Morris County were considered of little value. At the present time the man that is so fortunate as to have a well defined deposit of iron ore on his mountain range, which was then considered worthless, is now regarded as possessed of property of great value. The value of such property is

constantly advancing. Many persons at the time I mention attached no value whatever to the iron ore on their property, and often sold their lands for the valuation of the surface and timber it contained, without any consideration whatever for the iron ore. Some there were who tried the experiment of manufacturing iron; but, with very few exceptions, they broke down in the business—some from lack of experience, and more from lack of means to carry it on, and all, either directly or indirectly, from want of protection to the iron interest. Had there been that protection which was necessary, and in fact is always necessary, to every enterprise in its infant state, unless the demand is greater than the supply, they would have succeeded; but as it was, they had to abandon it in despair, and sell their property for a nominal value, as many then did "*with the idea*" that it was better to get little than nothing at all. Property that was then not considered worth five thousand dollars is now valued at fifty thousand dollars, and, in some instances, more. With all those rich deposits of iron ore which Morris County contains, there is but one blast furnace in the county; and, with the exception of Trenton Iron Works, and their connection of blast furnace at Phillipsburgh, there is but one iron manufacturing establishment worthy of the name in this State. This is the Boonton Iron Works, located at Boonton in Morris County. The number of mines or openings now in operation, which are of any note, as regards the quantity of ore mined and extent of their operation, is about twenty-five. There are many others that are not now in operation. These deposits vary much in thickness and also in extent, and their duration in regard to particular thickness in length or depth is very uncertain, as they are not only subject to become narrowed from the compression of the rock, but are in some localities very much subject to offsets, which, if they do not diminish the thickness of the deposit of ore, cause great inconvenience to the miner, and sometimes baffle him so as to preclude all hope of finding its continuation. The thickness of those deposits from which the ore is taken at present is from eighteen inches to nineteen feet, and I think that there are some much larger, but six or seven feet would be the average thickness. The present mines are located, with one or two exceptions, from one and a half to four miles from the Morris Canal; and from the imperfect state of the roads, the carting of the ore becomes very expensive. Some of those mines produce a great amount of water. The expense of drainage is often a heavy tax, and adds greatly to the cost of mining the ores. As all those mines which are worked to any great extent require a considerable power, the power chiefly adopted is steam. Except at those mines owned by the Boonton Iron Company, water power is adopted. There are quite a number also where horse power is used, but mining to any great extent with horse power cannot be done unless with much inconvenience and great expense, as the machinery is required to be in almost constant motion; and if idle for any time by accident or otherwise, the machine has to be driven at a greater velocity of speed when set in motion, in order to overcome the accumulation of water. At those twenty-five mining operations in this county there are seven steam engines varying from ten to twenty-five horse power. Those engines all consume coal for the generation of steam. The cost of the coal at the mines is on an average price of $5 75 per ton, and each of those engines ordinarily consumes from eighteen to two thousand five hundred pounds per day; and to this add engineers' wages, wear and tear of machinery, oil, &c., and it will be seen that the expense of drainage is considerable, and will be found to amount to not less than fifty cents per ton on all the ore mined at those mines where steam engines are used.

Although those deposits of iron ore are undoubtedly of an irregular formation, yet some of the mines have been for a great number of years in constant operation, and have produced a very large amount of ore. The Swedes mine near Dover has been in operation for more than thirty years, and has within this last ten years alone produced not less than one hundred thousand tons of ore. Of the twenty-five mines at present in operation thirteen are owned and driven on by companies having blast furnaces, and of course consume

the ore they mine. The number of tons of ore mined and taken from all the mines in operation in Morris County in the year 1856, was not far from ninety thousand tons. Of this amount, about forty thousand tons were mined by companies consuming their own ore, and about fifty thousand by the different individual owners, &c. At present the mining operations are progressing very rapidly, and with every appearance of much increase in the production of ore this present year over any other; and there is no doubt, I think, but that the production of the iron mines of Morris County, for 1857, will be over one hundred thousand tons.

Respectfully yours, &c.,

PRACTICE.

IRON WORKS OF SOUTH WALES.

From the European correspondence of the Pottsville Journal, we take some extracts relative to the Dowlais and other Iron Works:

Merthyr is situated on the River Taff, and its tributary, the Morlais Brook, at an elevation of from 500 to 1200 feet above the sea, which is 20 miles distant. Unlike most towns in England that are at all noted for manufacturing industry, the atmosphere of Merthyr is by no means smoky, though four of the largest Iron Works in the world are located within it.

The cause of this un-English cleanliness is the character of the Coal, which contains but a small proportion of bituminous matter, and indeed approaches closely to Anthracite—containing from 85 to 90 per cent. of Carbon, and being used without *coking* in the blast furnaces. It seems to compound to the "Semi-Anthracite" of Treverton and Lykens' Valley in our State of Pennsylvania.

The four great Iron establishments, whose workmen constitute the population of Merthyr, and whose names are "Dowlais," "Pen-y-darran," "Cyfarthfa," and "Plymouth," should they stop operations to-morrow, would throw out of work a body of 16,000 trained mechanics, and have an invested capital of at least twenty-four millions of dollars unemployed.

Their size and production may be thus tabulated:

	No. of Blast Furnaces.	In Blast 1856.	Weekly production of Pig Iron.
Dowlais Iron Works	18	16	2500
Cyfarthfa "	18	17	2500
Pen-y-darran "	8	8	1000
Plymouth "	8	7	900
Total	52	48	6900

The "hot blast" plan is in operation at the "Dowlais Works" only, where seven of the eighteen furnaces are hot blast, the remainder cold blast. At none of these works is the waste of gases of the furnace utilized—as is done in many of the Iron Works to the Eastward in Wales—either for heating the blast, or as a substitute for fuel in the boilers of the steam engines.

To give our readers some conception of the *steam power* used in this country, in the manufacture of Iron, we submit the following statement of the engines engaged at Dowlais works.

First, for the *Blast*, there are five engines with the following power:

No. 1—500 horse power.
No. 2—380 " "
No. 3—200 " "
No. 4—250 " "
No. 5—400 " "

Total, 1730 horse power, of which all but No. 3 are "high pressure."

No. 1 of these is said to be the largest and finest steam engine in Wales, the power being no less than 500 horses.

Steam Cylinder, 4 ft. diameter; stroke 14 feet.
Blowing Cylinder, 14 ft. diam.; stroke 12 feet.
Air Valves, number 70; size, 2 feet square, of leather and sheet iron.
Alternating beam, 40 feet long; weight 28 tons.

This engine is supplied with steam from 10 boilers, which consume 40 tons of Coal every day of 24 hours. It drives the blast for 6 furnaces, and accomplishes the work of 3 engines formerly.

No. 2 is a high pressure engine, on what is called the "compound principle." There are two cylinders, one at each end of the alternating beam, and the steam, after performing its duty in the first, escapes into the second, which, being larger than the other, allows the steam to expand. The total power is 380 horses. The piston-rod at one end has 10 feet stroke: at this end two rods descending from the beam work the piston of the blast cylinder situated below. This immense cylinder is 14 feet in diameter, and has 70 air valves. Engine No. 2 is supplied with steam (at a pressure of about 55 lbs.) from 6 boilers, using each 4 tons of Coal in the day of 24 hours.

These five monster engines have in all 40 boilers, which, at 4 tons each, use 160 tons of Coal daily—a demand large enough to keep quite a respectable Pennsylvania Coal mine going pretty steadily to satisfy it. And if to this be added the consumption by 14 stoves (two for each of the 7 hot-blast furnaces) for heating the air-current, amounting to 20 tons daily, we obtain a total consumption of 180 tons of Coal per day, attending the *mere introduction of air* to the metallurgical process as conducted at these mammoth works!

Secondly, for the *Forge*, there are nine steam engines.

2 of	160	horse	power	each,	320 horse power.
4 of	150	"	"	"	600 " "
1 of	100	"	"	"	100 " "
2 of	50	"	"	"	100 " "
Amounting to					1120 " "

Thirdly, for the *Fitting up and Mending Shops*, there are 3 engines.

2 of	35	horse	power	each,	70 horse power
1 of	"	"	"	"	15 " "
Total					85 " "

Fourthly, for the *Colliery and Iron Pits*, there are 10 engines, with 600 horse power.

The summing of these items gives a total of 27 steam engines, and 3,535 horse power—nearly one-third of the aggregate steam power used in mining in Schuylkill County. To which should be added 6 Locomotives engaged in drawing Coal, Ore, and Limestone, from the surrounding mines to the furnaces, and the manufactured rails and bars to the Taff-Vale Railroad, which conveys them a distance of 60 miles to the sea coast at Cardiff.

The entire consumption of Coal at the Dowlais Iron Works may then be summed up as follows:

By 16 Blast Furnaces,	5000	tons	per	week.
" 14 Stoves (for heating the blast of 7 furnaces),	140	"	"	"
" 5 Blast Engines,	1120	"	"	"
" 22 Forge, Shop and Mine Engines,	900	"	"	"
" 6 Locomotives, say	100	"	"	"
" Rolling 2000 tons per week of Rails and Merchant Iron,	5000	"	"	"
" 6000 workmen, offices, &c.,	1000	"	"	"
Total,	13,260 tons of Coal per week, or a little over 2000 tons daily.			

This immense output of Coal is mined on the lands of the proprietor, Sir Ivor Guest, in 12 pits and 17 or 20 levels for Coal and Ore. One of these levels opens directly into the yard of the works, beneath the furnaces, supplying 300 tons daily for the purposes of the forge, as follows:

For the Balling furnaces, 3 tons of Coal per 5 tons of Iron.

For the Puddling furnaces, 1 ton of Coal per 1 ton of Iron.

For the 2d Balling, 1 ton of Coal per 1 ton of Iron.

The Coal and Ore are brought from all the surrounding pits—the Ore being mostly worked in open quarries, or patches on the mountain sides.

It would require almost the whole Cumberland Coal field, at steady work, to supply the demands of this one huge Iron establishment alone.

If the production of Coal in Pennsylvania is now—Bituminous and Anthracite—nearly 9 millions of tons yearly, when the Iron manufacture is in its infancy, what may we not expect of it, when the latter, fully expanded and developed at every point, fills our whole State with works on the scale of those at Merthyr Tydvil. V. J. P.

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IMPROVED ROLLS.

From time to time inventions have been patented with a view to supersede the large amount of manual labor involved by the introduction of the puddling process. Various compressing machines have been proposed for removing the oxidized impurities. The most successful and only one now generally employed is the blooming machine of Mr. Jeremiah Brown. This machine has been already described in the *Mining Journal*, but improvements of the greatest importance have recently been made, by which the inventor is enabled to make two rolls suffice instead of three. Mr. Brown's improvements are thus specified:—The invention consists of rolling or squeezing machinery, to be used in that stage of the iron manufacture at which the iron, after having been puddled, is subjected to compression previous to being rolled into bars, or made into other forms. The said machinery consists of two pairs of rolls, the largest pair being situated one over the other, as in ordinary rolls. The smaller pair of rolls is placed on the same level, one on each side of the large rolls, the said small rolls preventing anything between the large rolls from falling out. The large rolls are not cylindrical, but have, in transverse section, the figure of an involute curve, the radius of the curved surface passing gradually from a minimum to a maximum. Between these two points a portion of the roll is cut or hollowed away, so as to form a cavity, into which the ball of iron to be treated is placed. The ball of iron is delivered by the rotation of the upper roll on to the lower roll, where it is subjected to a rotatory squeezing process, by the gradually approaching surfaces of the rolls. The surfaces of the large rolls are furnished with teeth, so as to give them better hold of the ball of iron. The ball is delivered on an inclined plane by the lower roll. The side rolls are made to slide horizontally, so as to accommodate themselves to the changing size of the ball of iron. As the ball diminishes in diameter, it increases in length, and the ball receives a series of blows on its ends, by means of percussive machinery, which acts through the side framing of the machine, and is worked from the large rolls. The journals of the upper roll may be provided with springs, so as to permit a small amount of yielding in the said roll.

The invention consists further in improvements in machinery used in the manufacture of iron, for which letters patent were granted to the inventor in 1847. The said improvements consist in introducing percussive machinery to compress or strike the bloom at one or both ends, in place of the collars on the rolls, which are described and represented in the specification of the said patent. When it is desired to make a bloom of larger than the ordinary size, two or more balls are joined together by pressing them in a chamber or hopper, previous to putting them into the blooming machine, which in this case is of larger size than when an ordinary bloom is required. After the

bloom leaves the machine, it is placed upon two rolls having ribs on them, and revolving in the same direction, one at a greater velocity than the other. By the action of these rolls, the bloom is cleaned from the scoria attached to it, the ribs on the rolls scraping off the said scoria, which falls down between the said rolls.

Experiments have recently been made at the works of Messrs. Beasley and Farmer, Smethwick, with Messrs. Brown's machinery for rolling iron. The bar produced was of a taper form, for a railway crossing; the rolls not only produce this form of bar, but, from their peculiar shape, they gather up and compress the iron on the sides of the bar and give great density to the heads of the rail. The rolls are without guards or guides to prevent the collaring of the bar, which, however, is delivered perfectly straight from the machine. The success of the invention is beyond a doubt, and those practically acquainted with the iron trade assert that a real advance has been made in the application of rolling machinery to the making and fashioning of iron.—*London Mining Journal.*

CASTING MALLEABLE CAST-IRON IN METAL MOULDS.

Mr. D. Morrison, Bordesley Works, Birmingham, G. B., has patented some improvements in the manufacture of articles from malleable cast-iron, which consist in the use of moulds of metal, by preference of cast-iron, each mould being of two or more parts, according to the nature of the article to be cast therein. Make the parts of each mould to fit accurately together, and the interior surfaces very smooth. When using such moulds, either smoke the interior surfaces, or brush the interior surface over with black lead, and heat such moulds to a low black heat before running in the metal. By thus employing metal moulds the same may be used again and again, and the articles cast therein will not only be more smooth, but a considerable saving will result in not having to make a new mould for each article to be cast.

TO PREPARE A SOLUTION OF BRASS.

Dissolve 1 lb. (troy) cyanide of potassium, 2 oz. of cyanide of copper, and 1 oz. cyanide of zinc, in 1 gallon of rain or distilled water; then add 2 oz. of muriate of ammonia. This solution is to be used at 160° Fahr. for smooth work, and from 90° to 120° for ornamental work, with a compound battery of from three to twelve cells.

Gold can be deposited of various shades, to suit the artist, by adding to the solution of gold a small quantity of the cyanides of silver, copper, or zinc, and a few drops of the hydro-sulphuret of ammonia.

COLLINS IRON COMPANY.

The amount of iron manufactured by this company for the year ending December 31st, 1856, was 10,949 half blooms, weighing 725 tons, 1,108 lbs. This amount is small when compared with the products of many other iron works in the United States, yet it should be remembered that these works are scarcely established, and it cannot be expected to do as well as older and more extensive companies. Work was suspended from the 8th of March to the 2d of June, of last year, which of course detracted largely from the amount of iron manufactured. We have not learned whether the directors will declare a dividend or not, yet we can see no reason why they should not, provided the profits have not been used in permanent improvements. The actual cost of manufacturing iron will not exceed $40 per ton, and some place it as low as $25 per ton. The price of this iron in the market has not been, we believe, less than $60 per ton, at which price the Collins Co. would realize a profit on their iron, of nearly $15,000. This company has been looked upon with much interest by capitalists, to ascertain if iron could be made here at a

profit, yet we do not, with all due respect to the company, consider it a fair criterion to go by. It is an established fact that it requires *capital* in considerable quantity to carry on the iron business successfully. From our own observation and from conversation with those who are posted in these matters, we are satisfied that if this company can make ten per cent. on the amount now invested, they would make fifty per cent. on three times that amount. This is the reason we disclaim against capitalists taking the iron companies which are now in operation here, as a guide. We have not time to discuss this matter further now, but shall take it up again.

The product of the farm belonging to the Collins Co. was as follows:

1100 bushels potatoes, 225 bushels turnips, 50 bushels beets, 200 bushels carrots, 25 tons oats in straw, and hay.

These products at present prices are worth at least $2,500.—*Lake Superior Jour.*

JOURNAL OF GOLD MINING OPERATIONS.

TREASURE SHIPMENTS FOR 1856.

The total shipment of treasure for the year 1856 from San Francisco amounts to $50,988,768 50, being $6,348,667 97 more than the previous year. Of this sum, $39,708,896 42 went to New York.

The exports of treasure from the port of San Francisco, for the past six years, foot up as follows:—

Exports in 1851	$34 492,000
Exports in 1852	45.779,000
Exports in 1853	54,963,000
Exports in 1854	51,439,000
Exports in 1855	45,182,631
Exports in 1856	50,607,434
Total	$282,545,065

A NEW INVENTION.

Every invention calculated to simplify and cheapen mining operations is of a vast importance to the citizens of California; and we have looked with much interest upon the efforts of our mechanics in their endeavors to apply steam power to the tedious and expensive process of tunnelling. The amount of money annually expended in this branch of mining in California is enormous; and the delay entailed by the slow process of working by hand is a source of great annoyance to our go-ahead miners.

We have not yet learned whether the "Tunnel Borer" lately put into operation at Iowa Hill, has proved itself of practical value—but sincerely hope it has, or soon may do so.

We have noticed within the past week that still another machine for the purpose of "drilling by steam," has been put to a trial in Sacramento, with very flattering results. This machine is designed both for tunneiling and for general blasting purposes. We copy the following description of it from the Sacramento Union—"The machine will work in a tunnel five by six feet; is arranged to work while stationary on the track. The variation of the angle in working the drill does not affect the drill, it being only necessary, after running in the machine, to determine where to point the drill. The force of the blow with the hammer attached can, by the turn of a screw, be regulated so as to be equal to three or four hundred pounds, or barely sufficient to crack a

walnut, and, in rapidity, the blows may be made as frequently as one hundred and fifty times a minute. The machine was invented by Mr. Todd, of this city, by whom it is owned, in company with Samuel Green. They are now engaged in building another machine of the same pattern, which they intend sending to Iowa Hill for trial. As the machine can be worked by two or three men, it will supersede the use of the sledge, and enable miners to run a tunnel in about one quarter the time usually employed, particularly where the rock is hard. The invention is worthy attention. From our observations of its operations we can but regard it as a triumph of the skill of a Sacramento mechanic in a direction most acceptable to the bone and sinew of California."

AMALGAMATORS.

We have often been called upon to notice Amalgamators of various kinds, old and new; but of the great numbers which have been introduced to our notice, we know of but two which are worth the first cost of the materials of which they are constructed; these two are the "Hungarian Tub" and "Stetson's Self-Operating Amalgamator." The first has been in operation by parties in this place for about four years, and is a most excellent contrivance for saving gold. Until the introduction of Stetson's Amalgamator, it was undoubtedly the most efficient apparatus in use; but we are fully satisfied both from our own experience and observation, and from the reports of those who have been using it ever since its invention, that the latter machine must eventually take precedence of every thing else. The simplicity of its construction, the manifest superiority of the principle upon which it is based, and the trifling attention it requires while in operation, recommend it at once to the judgment of every experienced miner.

The machine is now being very generally introduced into the mills in this vicinity, and we are fully persuaded that it will soon come into almost or quite universal use throughout both California and the Atlantic States.

In the trials to which it has been subjected it has generally been placed below all other processes for saving gold, and where it is now so placed it is averaging from $40 to $200 per week, according to the amount of rock crushed and the richness of the same. We are fully confident that wherever it is properly placed and looked after, it cannot fail to give the most perfect satisfaction.

Mr. Stetson, the inventor, intends for the present, to make his home at Sacramento, where he is prepared to answer any orders or inquiries that may be addressed to him in relation to the machine.

JOURNAL OF COPPER MINING OPERATIONS.

The circular of Messrs. Dupee, Perkins & Sayles, Boston, furnishes the annexed interesting statistics in relation to Copper-mining on Lake Superior:

"Transactions continue limited. Owing to the recent extraordinary rise in copper in the English markets, the best class of mining shares were held here for a few days for advanced prices. It was soon ascertained, however, that the movement on the other side was entirely artificial; and that the demand for ingot copper in the United States was no greater than the supply. Hence, at the close of the past week, there has been more disposition to realize fair prices for the better class of stocks.

"It is nearly thirteen years since the commencement of mining operations by organized companies at Lake Superior. Notwithstanding but two mines

have as yet paid dividends, public interest in the adventures in that region is constantly increasing, so that skill in the economical management of every department of mining is sure to follow year by year. But while it is quite probable the mistakes in American mining have been, relatively, as few as those made in older countries, we have neglected means within our reach, which, rightly used, would have placed us much sooner on the road to remunerative results. It was ascertained, for instance, long since, that many of the mines must depend for profits on stamp work; and yet up to this very time but a single mining agent ascertains, monthly, the exact proportion of copper in a ton of stamp stuff, and knows to a grain, by accurate analysis, the value of the material he sends to market. There has been, in the aggregate, no deficiency of capital, but a waste of it, in distributing it over districts remote from navigation, and almost inaccessible for transportation, except in the winter season. In a word there has been, in an eminent degree, the same lack of good judgment and good management that proverbially characterizes the operations of joint stock companies.

"The former success of the leading manufacturing corporations of New-England may be, in a good measure, attributed to a mutual acknowledgment of a harmony of interests. Discoveries, inventions and improvements made by one were for the benefit of all. The mining adventures of Lake Superior require, on the part of every man interested, a similar acknowledgment. Every discovery in the geology of the district, every improvement in machinery, and every new method in details of mining should be communicated without delay to every location. Uniformity of wages, freights, and prices of supplies, as far as the nature of such matters permits, should every where prevail. To this end shareholders should insist on periodical meetings of the managers of the mines, and they should allow no man to hold a responsible position who is not willing to be taught by the experience of others.

"The amount of copper raised from the mines at Lake Superior, during the year 1856, has not been ascertained, nor can it be exactly estimated. Many of the mines allow their stamp stuff to accumulate through the winter, undressed, being satisfied that the delay of preparation for market is more than compensated by the saving of fuel, and by devoting the same amount of labor to the opening of the mine for stoping in warmer weather.

"The figures below are partially estimated, but are probably less than the truth. They do not show the relative increase of product, but only the increase of shipments in 1856 over 1855. 178 tons shipped from Ontonagon in 1856 were known to have been left over at that port in 1855. And, undoubtedly, more or less of the shipments from the other districts in 1856 were indebted to 1855. The navigation last year was prolonged to a later period than usual, allowing, up to November 15, at least, the clearing out of all the copper prepared for market.

"The following tables are digests, with slight corrections, from more elaborate ones prepared for *The Lake Superior Miner*, by Mr. Brunschweiler, of Ontonagon, and by Capt. Paull, of the North American Mine, and from official statements:

SHIPMENTS OF ROUGH COPPER, IN TONS, FOR 1856.

From Ontonagon	*Mass.*	*Brl. and Stamp.*	*Total.*
Adventure	27	118	145
Aztec	15	40¼	55¼
Douglas Houghton	¼	8¾	9
Evergreen	4¼	15	19¼
Flint Steel River	—	2	2
Forest	1	49	50
J. R. Grout	—	2	2
Mass	10	8	18
Merchant	—	¼	¼
Minnesota	1361	497	1858
National	55	60	115
Nebraska	11	22	33
Norwich	71	45	116
Ohio	—	¼	¼

Ohio Trap Rock	—	4½	4½
Peninsula	—	¼	¼
Ridge	4	58	62
Rockland	91½	108	199½
Toltec	11	49	60
Windsor	6	16	22
Total	1,668	1,099	2,767

From Keweenaw Point.	*Mass. Brl. and Stamp.*
Central	53
Central (Pittsburg and Boston)	1,548
Connecticut	22
Copper Falls	154
Fulton	2
North American	328
North Western	15
Phœnix	11
Total	2,128

From Portage Lake.	*Mass. Brl. and Stamp.*
Isle Royale	228
Huron	22
Pewabic	96
Portage	101
Quincy	20
Total	462

	Total shipments. 1856.	1855.
From Ontonagon	2,767	1,984
From Keweenaw Point	2,128	2,245
From Portage Lake	462	315
Total	5,357	4,544

COPPER RAISED FROM THE MINNESOTA, CLIFF, AND ROCKLAND MINES IN 1856.

	Minnesota. Tons.	*Cliff.* Tons.	*Rockland.* Tons.		*Minnesota.* Tons.	*Cliff.* Tons.	*Rockland.* Tons.
January	159	120	—	August	155	154	33
February	153	127	26	September	150	146	41
March	165	145	—	October	154	146	32
April	159	150	—	November	156	124	23
May	153	141	16	December	150	120	24
June	152	140	20				
July	153	134	30	Total	1,859	1,647	245

MINING MACHINERY AT THE MINES OF LAKE SUPERIOR, JANUARY 1, 1857.

Keweenaw Point.	*Engines.*	*Horse-power.*	*Heads of stamp.*
Cliff	6	209½	24
Copper Falls	5	110	50
Keweenaw	1	20	16
North Amer.	6	166½	20
North West	2	63	16
North Western	2	63	16
Phœnix	1	5½	12
Summit	2	14	8
Star	1	—	—
Total	26	651½	162

Ontanagon.	*Engines.*	*Horse-power.*	*Heads of stamp.*
Forest	3	76	24
Ohio Tr. Rock	1	26	24
Minnesota	4	182	12
Norwich	1	21	16
Ridge	2	49	8
Rockland	1	28	12
Toltec	3	98	32
Windsor	1	21	12
Total	16	501	140

Portage Lake.	*Engines.*	*Horse-power.*	*Heads of Stamps.*
Huron	1	—	8
Isle Royale	3	36	91½
Portage	2	16	40
Total	6	52	139½

"The aggregate cost of the steam engines is estimated at $308,700. Of the 26 at Keweenaw Point, three are portable engines. At Copper Falls the stamp heads are put down as 50, while two of them (Ball's machinery) are actually equal to 50 of the old style. Each stamp head should pulverize 2,000 pounds of rock in 24 hours. So that reckoning Ball's stamps equal to 50 heads, the aggregate machinery at the lake should crush 392 tons of 2,000 pounds per

diem, equal, at 1½ per cent, to nearly 6 tons of fine copper. The Phœnix Company's stamps are run by water power.

"The total product shipped from Lake Superior in 1856, reduced to ingot copper, results in not less than 3,600 tons of 2,000 pounds, worth, at 25 cents, $1,800,000."

THE COPPER PRODUCT OF GREAT BRITAIN.

[*From the London Mining Journal.*]

Copper.—Systematic explorations for copper were probably commenced in Cornwall about the year 1700. At first the annual amount of ore was very limited. Several causes operated at the onset to check the extension of this branch of mining. The drawing machinery was ineffective and quite inapplicable for mastering large quantities of water at considerable depths. The royalties or lord's dues were usually very exorbitant—one-sixth, one-seventh, and even one-eighth of the produce. The smelters, as they became more numerous, compelled the miner to accept such a rate for his ore as they might choose to impose. With the improvement of pumping machinery, and the adoption of more liberal royalties, the annual yield in Cornwall and Devon has reached 195,400 tons, and it may confidently be anticipated that this quantity will go on increasing. It is somewhat curious to notice the opinions which have been occasionally entertained by miners regarding mineral deposits—for a time the metalliferous copper lodes were held to exist only in limited areas in the western part of Cornwall. It was afterwards asserted that copper ore would not be found in remunerative quantities east of Truro Bridge. The discovery, however, of a large deposit of ore at Great Crinnis, in the parish of St. Austell, proved the fallacy of the latter view. Subsequently, other mines were worked profitably in the same neighborhood. Ultimately, the Caradon, or eastern district of Cornwall, came into notice, whilst Wheal Friendship was an important copper mine as early as 1796. Not many years ago, the wonderful deposit of Devon Consols was discovered, and numerous other workings in the same field have since been established. Elsewhere copper ore has been produced in great abundance. Ecton Mines, in Staffordshire, furnished at one period very large returns. The Pary's Mine, in Anglesea, also gave extraordinary supplies. Wales has, from time to time, furnished a limited quantity, and the yield from Ireland has been increasing for many years.

The quantity of copper ore raised in Cornwall and Devon, and sold chiefly by public ticketing, during 126 years ending 1855, was 7,884,305 tons, which realized 50,964,388*l* sterling. The mean price of the whole was 6*l*. 9*s*. 3d., and averaged for 70 years, 8 per cent. of fine copper. The return for 10 years, ending 1855, was twenty-five times greater than from 1726 to 1735. The average produce for 10 years, ending 1785, was 12 per cent., and for a corresponding period to the end of 1855 it had declined to 7½ per cent. For the current year it will probably be about 6¾ per cent. These figures indicate clearly the economic value of the improvements which have been effected in working our mines.

The mean produce of the vein stuff of Cornwall has been estimated by an eminent authority to be about 2 per cent. of dressed ore; consequently if this be applied to the number of tons of ore sold during 126 years, we shall have a quantity of no less than 31,537,220 tons rendered to the dressing-floors.

Copper ores raised and sold in Cornwall and Devon, in decennial periods for 126 years—from 1725 to 1790, and from 1794 to 1855 :

Date.	Tonnage of ore.	Tonnage of copper	Amount.	Average annual Amount	Average annual tonnage of ore.	Average Produce	Av. prod. per ton of cop'er ore.	Inc. of tonn. cop'er ore. †
	Tons.	Tons.			Tons.			
1726 to 1735	64,800	.....	£473,500	£47,350	6,480	.....	£7 15 10	1
1736 to 1745	75,520	.....	560,106	56,010	7,552	.....	7 8 6	1 16
1746 to 1755	98,790	.....	731,457	73 145	9,879	.....	7 8 0	1 52
1756 to 1765	169,699	.....	1,243,045	124,304	16,970	.....	7 6 6	2 61
1766 to 1775	264,273	.....	1,778,337	177,833	26,427	.....	6 14 6	4 10
1776 to 1785	304,133	36,496	1,827,006	182,700	30,413	12	6 0 2	4 69
1786 to 1795	*229,169	.....	1,359,724	.....	.....	.....	.....	.....
1796 to 1805	564,037	53.588	5,003,191	500,319	56,403	9½	8 17 4	8 70
1806 to 1815	726,308	62,550	6,056,260	605,626	72,630	8 6-10	8 6 9	11 20
1816 to 1825	926,271	75.986	6,044.627	604,462	92,627	8 3-10	6 10 6	14 29
1826 to 1835	1,352,313	108,801	8,088,220	808,822	135.231	8	5 19 0	20 86
1836 to 1845	1,486,840	111,770	8,547,059	854,705	148,840	7½	5 15 0	22 94
1846 to 1855	1,622,152	123,259	9,251,916	925,191	162,215	7½	5 14 0	25 03
126 years.	7,884,305	..... *	£ 50,964,388	.....	.....	.....	£6 9 3	
70 years.	.....	572,450	.....	.....	.....	8		

* Records entirely lost for four years. † Ratio to unity.

Copper ore raised from mines in Great Britain, and sold by ticketing in Cornwall and Swansea for 10 years, ending 1855 :—

Year.	Mines situated in Cornwall and Devon.				Other mines in the United Kingdom.			Total amount.		
	Ore.	Cop.	Value.	Pd.	Ore.	Cop.	Value.	Ore.	Cop.	Value.
	Tons.	Tons.			Tons.	Tons.	£.	Tons.	Tons.	
1846	150,431	11,850	£ 796,182	7½	19,311	1543	112,245	169,742	13,393	£ 908,427
1847	155,985	12,754	889,287	8½	15,218	1385	106,912	171,203	14,139	996,199
1848	147,701	12,422	720,090	8½	13,317	1186	75,492	161,018	13,608	795,582
1849	146,326	11,684	763.615	8	10,779	986	72,937	157,105	12,670	836,552
1850	155,025	12,253	778,224	7¾	11,966	1061	76 725	166,991	13,314	854,949
1851	150,380	11,807	782.947	7¾	11,451	1107	83,133	161,831	12,914	866,080
1852	165,593	11,776	975,975	7½	11,604	1092	100,858	177,197	12,868	1·076,833
1853	181,944	11,913	1,155,167	6½	12,749	1224	126,243	194,693	13,137	1·281,410
1854	187,103	11,964	1,192,879	6¾	12,026	1149	130,064	189,129	13,113	1·352,903
1855	195,193	12,378	1,263,789	6½	14,921	1276	136,918	210,114	13,854	1·400,657

Average produce of mines in Cornwall and Devon, for 10 years 7¼
ditto do other mines, for ditto 8½
Increase in value 54
Average monthly rate of wages per miner, 1855—Devonshire £3 7 0
ditto ditto Cornwall 3 6 0

The subjoined statement shows the relative value (for copper ores) of each centre of mining in Cornwall during 1855. The Penzance district, furnishing the lowest amount, is taken as unity :—

No. of Mines.	District.	Tons of Ore.	Tons of fine copper.	Amount.	Average produce.	Inc. of amount of copper ore ; ratio to unity.
16	Penzance	13,411	918	£ 93.390	6¾	1.00
11	St. Austell	15,355	1.218	124.393	7¼	1.33
13	Liskeard	22,826	1,566	159,551	6¾	1.70
54	Redruth	107,685	6,692	675,235	6¼ 1-16	7.22
94	Total	159,277	10,394	£1,052,569	6½	.....
19	Devonshire	33.824	2,071	200,348	6¼	2.14
113	Total	193,101	12,465	£1,252,917	.....	.....
	Sundries	2,299	124	11,902	5¼	.....
	Total	195,400	12,589	£1,264,819	.....	.....

The imports and exports of copper ore and copper from 1840 to end of 1855 show that the consumption of this metal is rapidly increasing, and that the production is not equal to the demand.

Imports and exports of copper ore and regulus, unwrought and wrought copper, and declared value of brass and copper manufactures, for 15 years, ending 1855:—

Years	*Imports.* Copper ore and regulus.	*Imports.* Copper unwrought and part wrough't.	*Exports.* Copper unwrought and part wrought.	Declared value of brass and copper manufactures exp'td.
	Tons.	Tons.	Tons.	
1841	48,597	559	570	£1,553,744
1842	49,856	809	341	1,801,742
1843	55,720	213	176	1,644,248
1844	58,406	1459	1296	1,736,515
1845	56,697	130	318	1,694,441
1846	51,624	609	490	1,558,187
1847	41,491	849	628	1,541,868
1848	50,053	1686	311	1,257,944
1849	47,433	2590	636	1,875,865
1850	45,862	4881	834	1,978,196
1851	42,126	5043	1285	1,639,156
1852	43,044	5181	1046	1,704,063
1853	50,393	5200	1639	1,854,331
1854	57,292	3218	1753	1,768,950
1855	66,599	8044	950	2,113,177
Total	765,193	39,871	12,273	£25,692,477

Imports.—Copper unwrought and part wrought ..... 39,871 tons
Exports.—Copper unwrought and part wrought ..... 12,273 "

Balance of imports for 15 years ..... 27,598 tons.

LAKE SUPERIOR REGION.

The following particulars relative to the progress of operations at some of the Lake Superior Mines have not been stated in these pages. We are indebted to the Lake Superior Journals for them:

Since our last issue we have been able to collect some news of interest from various sources, which if not new to all will be so to many. The PEWABIC Mine still continues in its onward course; and although without, as yet, any well defined vein, is undoubtedly worked at a profit. The secret of its success is in a great measure due to the mining Captain, who studies the formation thoroughly as the work progresses, and by so doing knows for a certainty upon which hand to turn. The importance of such a course cannot be overrated, especially in the present instance, where the most careful observation is required to retain the trace of the copper. With such management this mine, with its present prospects, cannot but prove profitable to the stockholders, so long as the Company confine their operations to the legitimate business of mining. The QUINCY Mine, which lies near the Pewabic, and generally possesses the same characteristics, is but little behind its neighbor, and with the same care and diligence can without doubt be made to equal it. From the information which we have from these two mines, the Quincy would be most likely to secure success by imitating closely the management of the Pewabic.

We have before us the report of the CONNECTICUT Mining Company, which it will be recollected own a portion of the "location" of the old Eagle Harbor Company, which was divided up among the Connecticut, Waterbury, and Eagle Harbor Companies. From this report we learn that J. R. GROUT, Esq., of Detroit, has been appointed a General Agent for the three Companies. Before making any extracts from the Report, it may be well to state that this location has quite a number of well defined veins upon it, many of them extending into the Lake. It is thought, by competent judges, that these veins can

be worked out to and *under* the water with profit. The whole, or nearly the whole location is rich in copper, and will afford a good field for future operations. The Report states that the instalment called for in December last, will be sufficient to carry on the operations this winter, and it is then hoped that the receipts for copper will be sufficient to pay the expenses of the mine. Mr. Grout visited the mine in September last, and says:

"The opening of the mine was projected by Dr. A. S. Blake, former agent of the Company. His discoveries at the point of the mine embraced four veins. The mine is opened on what is termed in his report, published by the directors in Jan. of 1854, middle vein. The openings as projected consist of three shafts, at distances of 330 feet apart, and an adit level of 1100 feet. Shaft No. 1 is situated at the base of the conglomerate rock near the foot of the bluff, and No. 2 and 3 in the declining slope of the range to the south. Thorough surface openings preceded the mining work and governed the plan of the mine. Shaft No. 1 to the depth of 18 feet, and 2 to 76 feet, and the surface adits were opened under Dr. Blake's charge.

"Mr. C. M. Petrie, the present superintendent, assumed charge, Dr. B. acting advisory, in May of 1854. During that year, the adit level was opened between Nos. 1 and 2 shafts, and 242 feet south from the latter; No. 3 shaft was sunk 25 feet, and the adit level opened at the surface 200 feet towards this shaft. Shafts Nos. 1 and 2 were sunk to the 10 fathom level below the adit, and that level driven 60 feet north of shaft No. 1. In surface work 2 whims were erected, 2 shaft houses, 2 frame dwelling houses, a frame barn, 5 acres of land cleared and improved, and some 60 rods of good road made—a log house had been built the previous year, now used as a smith shop, and a log house built before the purchase of the location. In May of 1856, instructions were given to reduce the mining force. These instructions the superintendent had judiciously anticipated. The small force of 4 miners continued, was confined to the 10 fathoms level going north. This level was extended 171 feet, when the force was returned to sink a winze 60 feet north of the shaft. During a part of September and October no mining work was done.

"I was at the mine in October and observed the character of the ground. The vein in surface adit to shaft No. 1 is 12 to 18 inches in width, carrying stamp work, lump and sheet copper. In the shaft and down to the adit level it is of the same character, and also through the level 200 to 250 feet towards shaft No. 2. It is very regular—veins nowhere being more so, or marked with smoother or better walls. Two hundred feet south of No. 1 shaft it looked very well. In shaft No. 2 it is similar down 30 to 40 feet, below which it is smaller, carries less copper, retaining however its regularity. At shaft No. 3 it is 2 feet in width. In shaft No. 1, below the adit level, the vein enlarges and improves in copper. At the 10 fathom level it is 2 feet wide, and very strong and regular. Throughout the extent of this level it is 2 to 3 feet wide, and well charged with fine copper, and lumps and masses weighing 10 to 100 lbs. Sixty feet north of the shaft this level exposed a mass of 3 feet in length by 5 to 6 inches thick, going below the bottom. At this point the winze was laid to prove the ground below.

"Mining work was resumed in November, and has since been continued —a force of 4 to 6 miners through the winter, and six to eight through the summer. The winze has been sunk 30 feet; shaft No. 1, 60 feet to the 20 fathom level; an adit opened from the shaft to the foot of the winze and 55 feet beyond, also 12 feet to the south of the shaft; the 20 fathom level extended north 30 feet; and 25 to 30 fathoms stoped in the vicinity of the winze.

"The vein has improved in size and productiveness throughout these openings. In the shaft it has been 3 to 4 feet wide, becoming richer and stronger in depth, being better at the 20 fathom level than above. At the winze it opened 6 to 8 feet in width, going down a compact vein lode of rich stamp, barrel and mass copper, masses weighing 1500 to 2000 lbs. *From Nov. 1 to Sept., 10 months, with the small force employed, and but little labor expended on stopes,* 36,393 *lbs. rough copper were raised and shipped. This ore melted re-*

turned an average yield of 78 *p. ct. the net proceeds of which were about* $6000. The entire expenses of the mine during the same period were $5,733 19, leaving a small net profit. In this result was the product of 255 tons of stamp mineral, which yielded 2 per ct. refined copper. Until the past season, the mining force was employed in opening ground—but little of the vein was taken down, and no labor expended to take out copper, and during the past season the principal force has been employed in extending the openings. The result has been satisfactory, and is very encouraging to stockholders. The superintendent thinks he will be able to ship 3 1-2 tons of ore for the months of September and October each, which will make a product of 25 tons for the year.

The expenditures at the mine during Dr. Blake's agency, were $14,372 59. During Mr. Petrie's agency they have been—for mining account, $16,219 77; construction account, $1,751 25; expenses account, $1,609 96; and agency account, $2,700; total $22,277 98. Total mining expenditure to 1st Sept. 1856, $36,650 57.

"The present appearance of the mine fully justifies a much larger working force. As soon as the coolness of the season gives the desirable ventilation, the force will be increased. About the first of November, it is proposed to employ 16 miners, which, with the necessary surface labor, will make an entire force of 25 men: and this may be increased as the opening of the mine is extended. The expense of the mine for Sept. and Oct., will be about $700 per month, and after the 1st of November, about $900 per month.

"The mine is expected to make the strongest in copper to the north of shaft No. 1. The 20 fathom level will be opened to the south of this shaft, and the workings extended in that direction as far as the ground shall justify. This level will be extended north from the shaft to the conglomerate belt, which is about 530 feet, and the 10 fathom level be continued north, and connected with the 20 fathom at the suitable point by a winze: in this part of the mine heavy mass copper is expected to be met with. As this work progresses, should the developments of the ground warrant it, it will be desirable to sink another shaft about 500 feet north of shaft No. 1. This will be necessary for a working shaft. It will pass through the overlying greenstone and conglomerate rock, and meet the 20 fathom level in the productive rock, at a depth of about 260 feet. This shaft will be a serious item of expense, and its necessity should clearly appear before it is undertaken.

"The stamp product of the mine renders stamp machinery now necessary. The use of the stamps of the North West Mining Co. has been obtained this season. Their machinery is distant about half a mile. The use of it, in consequence of the transportation, is not as economical as that which the Company would erect at the mine. If their machinery can, however, be had another season, it will be preferable to the erection of it by the Company. Improvements are now making in this class of machinery which may another year be fully established. They are esteemed to be valuable, and, should they prove to be so, it will be desirable to adopt them.

"The smallness of the mining force has rendered unnecessary further surface improvements since the season of 1854, and further expense of this kind will be unnecessary before another year.

"The agency of the mine has been managed with efficiency and prudence.

"There is a vein lying to the east of the vein of the mine, approaching the latter northward. It is about 70 feet distant at shaft No. 1. This is a strong copper vein at the surface. Another vein approaches the mine on the west connecting with it at a less distance northward. It is desirable to cross cut from the 20 fathom level and determine the position and character of these veins. There are two other veins, respectively 130 and 190 feet west of the mine. The latter is parallel to the vein of the mine, and is at the surface a good sized and promising vein. The vein in relation to which some correspondence has been had with Mr. Hill, lies about 60 rods to the west of the mine. Some work was authorized to determine its exact position and appear-

ance in the productive rock. From its proximity to the mine it may at any time be worked without other than the mining expenses. I am very confident that a valuable vein will be opened at this point. There are two other veins on the west part of the location, which are large and are believed to be valuable; they may constitute a valuable property for another company."

At the GARDEN CITY Mine a small force is employed this winter, on the "ash bed" in which there is no apparent change. Nothing doing at the CONTINENTAL Mine this winter, and what the future intentions of the Company are we have not learned.

The COPPER FALLS Mine is actively engaged, and at least paying expenses. This Company has probably been the most liberal in its operations of any one on the lake, taking up and testing thoroughly all the improvements in mining machinery, that have been presented from time to time. This course has done much towards placing mining operations on a sound basis, while its tendency otherwise has been to abolish speculation, and encourage mining companies to *earn* a profit. The surface improvements and experiments of this Company have of course been expensive, yet we understand that their outlays have not greatly exceeded their receipts. The trial of Ball's stamping and washing machine has been completed, and the stamping portion is pronounced perfect, but the inventor proposes to make some improvements in the washing. This is thought by some to be virtually admitting that his machine is not what he promised, yet, if he finally succeeds in this particular as well as in others, it will cover a multitude of short-comings and confer a lasting benefit on mining operations. The Copper Falls has considerable ground opened and a fair show of copper. We understand that the Agent intends to keep up operations as long as the proceeds pay expenses, and no longer.

We have received a copy of the Annual Report of the TOLTEC CONSOLIDATED Mining Co.; also a Circular, from which we learn that this Company will make an effort to commence operations again in the spring. The Agent of this mine made large expenditures in surface improvements, with the expectation that the mine would give a large yield, in which, however, he was disappointed. His course does not seem to have met with the approval of the Directors, as they believe that the appearance of the mine did not warrant them. In reference to this the Circular says: "Future operations will be directed to the opening of the vein alluded to by Mr. Hill," (of which we shall speak presently,) "and all the money hereafter expended will be for *strictly mining purposes;* and this can be done at a very limited expense, as no further outlay will be required for surface improvements or machinery." The mine at its present openings does not show much copper, yet its situation is such as to warrant further operations; indeed from the information which we have from private and uninterested sources, it would be folly to abandon the mine without making a thorough exploration of the whole location. We do not like to place too much confidence upon the statements of interested parties, and the foregoing is written without reference to the extracts from the circular. We will however add one or two more extracts, it says; "The Toltec location has the same geological position as 'Minnesota,' 'Rockland,' 'National,' and 'Superior' Mines; and there can be little doubt that a well-directed exploration will result in the development of new and valuable veins." Hon. S. W. Hill wrote to the secretary, Dr. Clark, in November last, as follows:

"I want you to give me authority, early next Spring, to examine the Toltec location for the Minnesota south vein. If I do not find it in six weeks to two months, with six to eight men, if the rock can be found when search will be made, I will lose my time and pay all of expenses. I *know* I can find it. I can go to the location this Winter, and open it, if you wish it done."

An assessment of one dollar per share was levied upon the Capital Stock, payable in January last. This amount it is stated will be sufficient to pay off the indebtedness of the Company, and enable them to proceed with their operations. The course which the Company have now marked out is truly grati-

fying, and if they do not meet with better success than heretofore we are greatly mistaken.

The following table of shipments we clip from the Ontonagon *Miner* of Jan. 17th, a portion of which we have before given:

Cliff	3,095,404
North American	645,498
Connecticut	44,080
Central	105,487
Fulton	4,500
North Western	30,683
Copper Falls about	396,000

This last named mine shipped some pounds more than the amount in the table.

The following is the amount in round numbers shipped from the Portage Lake District.

Isle Royal	223
Portage	101
Huron	22
Quincy	20
Pewabic	103

The whole amount of copper shipped the past season as given in the report of the Superintendent of the St. Mary's Falls Ship Canal, through which it all passed, is 10,452,000 lbs.

JOURNAL OF SILVER AND LEAD MINING OPERATIONS.

ANTIMONY, BISMUTH AND COBALT.

In a lecture recently delivered before the Royal School of Mines, in England, on the property of these metals, the lecturer, Dr. Percy, remarked as follows:—

When copper was mixed with antimony in excess, it formed a regulus of beautiful violet color, which by the old alchemists was denominated regulus of Venus. It frequently occurred with sulphur, and the general per centage of the ores was 72.8. From Borneo they had recently received some large supplies; and it is said that from this source Rajah Brooke had made a great deal of money. A simple method of melting antimony was taking a large crucible, say one of 20 lbs., placing this in a position where it could be kept comparatively cool, and inserting in it another crucible, which had to be surrounded by charcoal and heated, the lower one to be well luted to the upper, this to have a cover on the top: an aperture being made in the upper, as soon as fused the melted antimony would drop in the lower, and by this process it could be saved. It was not necessary for him to enter into many details. When melted it was called martial antimony; when cast into moulds, on the surface it presented a star-like appearance, and the smelter had a particular pride in presenting this sort of surface. A cake of antimony was then shown with the form described. Antimony entered largely into the composition of type metal; what was considered a good mixture for this was three parts lead and one antimony, sometimes a small quantity of tin was added. If type metal was made too ductile, the letters would get out of shape and become distorted, and if too sharp they were apt to spoil the paper; he did not believe there was any specific standard for type metal, as in many cases, the several founders had each a formula of their own. When antimony was alloyed with copper it was found brittle; the specific gravity of this alloy was greater than the mean of the two metals. It had been proved that antimony

had been used in the composition of bells, and a work was published in Madrid, in 1567, which stated that several bells in Spain contained that metal. The Great Tom of Lincoln, and the bell of York Minster, contained antimony. According to assay, the Great Tom of Lincoln contained—copper, 74.70; tin, 20.61; antimony, 3.72; nickel, 0.58; iron, 0.09. These two last metals were probably introduced accidentally, in combination with others; while, at the same time, they had discovered traces of lead and zinc. The Chinese had likewise used antimony for the purpose of making mirrors. This composition consisted of—copper, 80.83; lead, 9.71; antimony, 8.43; and of iron a mere trace.

A patent metal had been invented by Mr. Wetterstedt, for the purpose of sheathing ships: he had not heard much of this; and therefore, presumed its application had not been so successful as had been anticipated. This metal was composed of—antimony, 4.3; lead, 4.4; mercury, 1.3. The several ores of the mineral were then described, as well as the mode of assaying, which the lecturer described as being very simple, and best to be done on a large scale, so as to afford a fair average assay.

Bismuth has been known for the last 300 years. At first it was mistaken for lead, and as such often used in cupellation. Its ore occurs with several other metals, more especially cobalt. Commercial bismuth was never pure, and sometimes it contained as much as 60 oz. of silver to the ton, and gold which would be worth extraction, and this he wished to be made publicly known. According to Scherer, the specific gravity of the crude metal was 9.783, while that of the pure metal was 9·779. Its melting point was 264°; it did not sensibly oxidize when exposed to moisture. It was occasionably produced in nickel refining. The metal was obtained easily; the most simple way was by liquation. A description was then given of the old method of obtaining bismuth, as well as the furnaces introduced by Plattner, at Schneeberg, and Johan Georgenstadt, in Saxony. Bertheir had stated that an alloy of 66 parts of lead and 34 parts of bismuth was more tenacious than lead, possessing a color between tin-white and lead-gray. This could be beaten out into thin foil, and was fusible at 166°. Bismuth could be mixed with mercury without the latter losing its fluidity. Lead and bismuth were often used for the purpose of adulterating mercury, and bismuth was likewise employed for the purpose of silvering glass; this process was then described. With regard to cobalt and nickel he could enter largely into details, but having had access to the manufactories in Birmingham, where the most unreserved confidence had been shown him, he was, consequently, bound in honor not to divulge all he knew; however, he would tell them as much as he consistently could.

Cobalt had been used as a coloring matter in ancient times, bu the blue glass and the enamels in the Museum which he had examined had received their colors, from copper, not cobalt. In Saxony, and Norway, where there are large establishments for the reduction of cobalt, and the operations there were carried on with great secrecy, about sixteen years ago his late friend, Mr. Askin, of the firm of Evan and Askin, had introduced the manufacture of cobalt there, and this had completely revolutionized the trade. What had been sold some years since for 2*l*.2s. per lb. now only realized 18s. The mode of separating cobalt from nickel could be found in Gmelin's *Hand-book of Chemistry*, and other works. The oxide of cobalt had been found in Missouri, accompanied with oxide of manganese. The introduction of artificial ultramarine had greatly lessened the price, it now being used in several instances in lieu of cobalt. The ores of cobalt were then described, as well as the various coloring matters and combinations obtained from them, which were illustrated by specimens of the metal in its various stages.

MISCELLANIES.

LIQUID QUARTZ.

In a recent number we referred to the invention of Count Dembinski for extracting gold from quartz, by dissolving the latter by the aid of carbonate of soda. The chief merit in the invention was the fact that from the soda being recovered after each operation, the cost of extraction was comparatively nothing. One of the products obtained is silicic acid, of the uses of which in the arts, and its general value, Count Dembinski states that, besides being applicable to a variety of industrial purposes, it can be employed for the purpose of silicatizing or petrifying wood artificially. Wood having by means of hydraulic pressure been saturated by it, is thus protected from rot and from being worm-eaten or destroyed by ants. This would be of importance for wood used in building, but particularly for sleepers used in the construction of railway. Wood simply wetted with dissolved silicic acid, is penetrated by it to the depth of about one-eighth of an inch, and will now take a fine polish of marble or rather agate, giving it a most elegant appearance. Mixed with lime, the dissolved silicic acid forms an extremely hard, insoluble, hydraulic cement, forming silicate of lime. If added to soap in certain proportions, it increases considerably its detergent qualities, giving it at the same time a very beautiful marble-like appearance. The silicic acid, having by the precipitation process, already described, been liberated from all extraneous metallic oxides, metals, and other substances, can be made use of in the manufacture of the finest looking-glasses and crystal glass. In this state of solution, the silicic acid is in the most proper state to be, by means of a simple chemical process, reduced to silicium—a metal perfectly similar to silver in color, brightness, malleability and other qualities. It is, however, nobler than silver, because, except by fluorhydric acid, it is, like gold, not attacked by acids. One ton of pure quartz contains about 690 lbs. of metallic silicium, the price of which is at present five times that of silver. These statements refer only to its properties in its liquid state; when calcined and used as a powder, it is said to form, when mixed with oil, a perfectly white and opaque varnish; and from the mathematical formation of its particles, and extreme hardness, it is adapted for grinding, and capable of entirely superseding emery for the purpose.

MINERAL WEALTH OF WALLACHIA.

Mercury abounds in the neighborhood of Pitesehti, and among other localities in the district of Gorgia. At Baia, Amma, Krasehne, &c., iron and pyrites are found. The Austrians had undertaken the working of the iron and copper and quicksilver mines when they occupied the principalities, but all is now abandoned. At Gesseni there are coal mines. At Denle and Roche very fine amber is found. There is some bad bitumen at a short distance from Bucharest, but that which has been used in the lame and impotent attempt to make decent trottoirs in the city came from the Dead Sea. Stone is scarce and bad; the sort generally met with is an agglomeration of calcareous and silicious molecules, spongy and coarse in structure, and utterly unable to resist the action of the weather. Hence the tumble-down, dilapidated appearance of all the houses in Bucharest. Chalk is abundant. The rock salt of Wallachia is magnificent, and is found in masses of immense size. Three mines are worked at present, partly by convicts and partly by free laborers, and from these have been taken every year, time out of memory, more than 20,000,000 okas, an oka being about 2 lbs. 14 ozs. avoirdupois. The mines are monopolized by the Government, and the royalty on them annually is not less than 18,000,000 of piastres, a piastre being about 4d. English money.

TREATING METALLIC ORES.

Chevalier G. Hahner, of Leghorn, in Tuscany, has invented a new process for treating metallic ores, which embraces chemical principles deserving the consideration of all mineralogists. The object of this invention is to decompose certain metallic oxides, and especially the oxide of copper, at a high temperature, in the presence of vapors of water and of silica, by means of alkaline chlorides, or other chlorides forming oxychlorides, or chlorides soluble in water—avoiding the loss of metal from the formation of free soda, or soda combined with silica, by the addition of an acid; and in separating the metals and other substances contained in the solutions. To form the oxides, the ore is submitted to roasting, either in the open air or in kilns or furnaces, for the purpose of expelling sulphur, arsenic, and other volatile substances, and rendering the ore more friable. If the metallic rock contains calcareous substances, it must be burnt in a similar manner to lime, and dissolved in water; the oxides of the ore will deposit at the bottom of the vessel in which the lime has been dissolved and driven off. Oxidized and other ores which do not contain sulphur or other mineralizing substances, only require to be brought to a red heat. The ores, treated as described, are then reduced to powder by the ordinary means, and again roasted in a reverberatory furnace—a small quantity of coke, charcoal, coal dust, or other combustible being added to facilitate the operation. To decompose metallic oxides obtained as described, and also other oxides, the red hot ore remaining in the furnace, after being completely roasted, is mixed with an alkaline chloride (chloride of sodium being preferred on account of its low price), in the proportion of about two parts, by weight (more or less according to the nature of the ore), of chloride for each part, by weight, of metal to be extracted from the ore. To obtain a more perfect mixture, an equal weight of ore already roasted is intimately mixed with the chloride, previous to its introduction into the furnace, and then moistened if dry. The moistened chloride, or mixture of chloride and roasted ore, ought then to be incorporated as intimately as possible with the red hot ore in the furnace, and kept in a continual movement and at a red heat, until the smell of muriatic acid becomes less perceptible, and the ore commences to adhere to the workmen's tools; the ore is then withdrawn from the furnace, and a fresh charge added. It is advantageous to leave the red hot ore thus withdrawn for some time, in heaps, which renders the process still more perfect. If the ore contains no silica, it is requisite to add about ten per cent. of this substance. The ores, treated as described, are then submitted in a hot state, if possible, to lixiviation. The inventor adds to the water employed for the lixiviation of the roasted ore, about five parts, by weight (more or less, according to the nature of the ore), of sulphuric, muriatic, or other acid, to one thousand parts, by weight, of ore, to render more soluble the oxychlorides or chlorides, and to decompose the free soda, silicates of soda, &c., which may have been formed during the roasting, and which would cause a great loss of metal. The vessels in which the lixiviation is performed may be of wood, and of any form and dimensions, according to circumstances; they should be furnished with an ordinary filter, to allow the water to run off freely. The precipitation and purification of the metals contained in the solution can be effected by the usual process. The copper may be precipitated by common ashes, lime water, and caustic water; and the products obtained may be used in the manufacture of different colors, salts, or reduced to the metallic state in ordinary furnaces. The copper may also be precipitated in the state of arsenite or arseniate of copper for the formation of green French paint by means of a solution of arsenite or arseniate of potash.

INVENTIONS, DISCOVERIES AND IMPROVEMENTS.

Ventilation of Mines.—A new method of ventilating mines is described in the London Mining Journal. It contains a reservoir, or hydro pneumatic box,

placed on one side of the adit level, supplied with water from a cistern on the surface. A metallic tube descends from the cistern to the vessel in the adit, and the supply is regulated by a self-acting valve. At the top of the metallic tube is a glass case, nicely regulated by a slide, which being suspended at a certain point admits no more water than is necessary. To draw in the largest possible quantity of air, a vortex is formed, and a continuous stream of air and water, varying in proportion according to the distance between the reservoir and the hydro-pneumatic box, is conveyed from the former into the latter. Here the water and the air are separated, the former escaping at the self-acting valve, and the latter being forced through a main tube, which branches off to any part of the mine.

SILICATES APPLIED TO PAINTING.

M. Kuhlmann has brought forward a process, involving the application of alkaline silicates to printing, a discovery, of which advantage has been taken in Germany, with the happiest effects, in the decoration of public buildings. Instead of oils and the ordinary vehicles, M. Kuhlmann uses a concentrated solution of silicate of potash, finding it to work well with vermilion, ultramarine blue, the ochres, oxide of schrome, and some others. These colors applied to a wall become, so to speak, part of its substance and almost imperishable. The wall is to be prepared, painted of any color, the whole surface sprinkled with a solution of silicate of potash, or soda—and it is covered with a permanent glaze. Wood, affected as it is by moisture, is not so well adapted for the silicated colors as brick or stone. The most suitable kinds are ash and horn-beam; but glass, porcelain, and metal, if quite dry, take the colors readily.

GAS FROM OIL—Retorts for making gas from oil are now constructed with an interior cone in each, and convex on the outside, to contain the fire. Each retort has also a false perforated bottom, under which is placed a mixture of charcoal and lime. The oil is permitted to enter the retort and drop on the red hot apex of the cone, when it is converted into gas. The gas cannot get out without passing through the perforated bottom and amongst the heated mixture of charcoal and lime, which tend to purify it. From the retort it passes to the cooler, where it is washed with water, and from thence into a receptacle for use.

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ART. I.—THE IRON MANUFACTURE OF GREAT BRITAIN—THEORETICALLY AND PRACTICALLY CONSIDERED. By WM. TRURAN, C. E. No. 15.

(Continued from page 221, Vol. VIII.)

FORGE ROLLS AND HEAVY GEARING.

THE shingler having shaped the puddle ball into a bloom, of a size suitable for the grooves of the rolls, it is delivered to the rougher, who proceeds with the rolling. The bloom is passed through the largest groove formed by the roughing rolls, then through the next smallest, until its sectional diameter is sufficiently reduced for the roller, when it is lifted to the finishing rolls, and after passing three or four times between the rolls, through as many grooves, a finished puddle bar is produced.

Two pairs of rolls form the puddling train; one pair for roughing the bloom, the other for finishing it into a flat bar. The grooves cut in the roughing pair are either oval, gothic, or diamond shaped; generally the first two or three grooves are gothic, and the other diamond. The finishing rolls are usually turned with grooves to produce flat bars, from 3 to 7 inches wide by ½ to 1½ inches thick. For the narrow bars a pair of finishing rolls will contain a sufficient number of grooves to work iron of two widths; for the widest bars a pair of finishing rolls are required for each width of bar. In some Scotch forges we observe the train composed of three pair, one roughing, one finishing for narrow, and one for wide bars. The employment of the second pair of finishing can be attended with no advantage commensurate with their first cost; the valuable space absorbed; and the power expended in driving them. The single pair is simpler, and having fewer connections, the liability to derangement is lessened. If a different width is at any time desired, and in the puddling forge, with good management, a large quantity may be rolled of each size, the rolls may be changed in 25 or 30 minutes.

In small forges, and others confined for space, the roughing and finishing grooves are sometimes seen in the same pair of rolls, which are proportionately longer. Their combination in the same roll may be advantageous under certain circumstances, but the weight of rolls required to be kept in stock, and the necessity

of changing heavy rolls for every alteration of width, are objections to this plan of working.

The durability of the necks and brasses is greatly increased by using cinder plates. A narrow groove is sunk in the body of each roll close to the ends, and a thin wrought iron plate inserted before lowering the top roll. By using this plate the cinders, which otherwise would escape on to the bearings, are excluded.

The bottom roughing roll is provided with a serrated fore plate and rest; the bottom finishing with rest, and wrought iron top and false guides. When water power is employed, and no danger exists of the guides being drawn in, single guides cottered down to the rests, as in the Cyfarthfa forges, may be employed. With loose guides the catches of the coupling crabs are constructed so that on a reversal of the motion by the engine, the train of rolls is disconnected; unless this provision is made the entrance of the cold iron guides on the backward motion is followed by a breakage of the rolls or standards.

The puddling rolls are generally 18 inches diameter by 3½ feet long between bearings; necks 10 inches diameter; length of roll over flutes 6½ feet. A pair will work four or five weeks without cleaning, and will be worn out, body and flutes, in four or five months. The immense strain thrown on the standards when rolling comparatively cold iron, requires castings proportionately strong. The aggregate area of metal in the two standards to each pair of rolls, in the weakest place, requires to be 230 inches; and the pinion standards are required to be of nearly equal strength.

The puddle ball after leaving the rolls is taken by boys to the cutting shears; in well arranged forges, these are placed opposite the finishing rolls. Shearing hot is the general practice, but when the lengths and sizes for the mill piles are not known, the old plan of dragging-out to the bank and subsequent cold shearing is followed. Stronger shears are then demanded, and the heavier labor necessitates the employment of men.

The velocity of the puddling rolls range from 35 to 80 revolutions per minute. The Staffordshire and Derbyshire probably work at the slowest speeds of any in this country. The Welsh are driven at from 50 to 80; the speed preferred by the workmen, and which is found most advantageous with all but very red short metals, may be stated at 56. If very red short a higher speed is attended with less waste. The shears may be driven at the same rate as the rolls, when the latter do not exceed 56 per minute; with a higher velocity the gearing should be proportioned to this number of cuts per minute.

We annex a statement of the dimensions of the heavy gearing of several forges which have been at work some years. Nos. 1 and 2 are driven by low pressure condensing engines; No. 3 high pressure beam; No. 4 high pressure horizontal; No. 5 high pres-

sure vertical cylinder and side rods; No. 6 low pressure condensing; No. 7 over-shot water wheel, 19 feet diameter by 8 feet breast. With the exception of No. 6 (the Hirwain), and No. 7 (the Forest forge), they are the Dowlais Puddling Forges.

TABLE SHOWING DIMENSIONS OF FORGE ENGINES AND HEAVY GEARING.

	1	2	3	4	5	6	7
Diameter of steam cylinder in inches	45	36	42	37	26	30	—
Length of stroke in feet	7	7	6	7	4	6	—
Number of strokes per minute	22	22	20	23	30	20	—
Horses power developed when rolling full throughout	260	190	260	360	150	70	62
Diameter of crank shaft bearing in inches	13·5	12	13·5	13·5	10	11	10
Diameter of crank pin in inches	7	7	8	6	4	5	—
Diameter of driving wheel to pitch line of teeth in feet	12·6	13·6	15	13·6	11·5	15·8	19
Length of tooth on face in inches	15	15	19	15	12	14	14
Thickness of rim of wheel in inches	4·3	4·7	5	4·7	3·8	3	3
Number of teeth in driving wheel	103	102	138	102	96	120	144
Pitch of teeth in inches	4·6	5	4·6	5	4·5	5	5
Weight on crank shaft bearings in tons	27	29	34	26	10	18	42
Diameter of spur wheel to pitch line in feet	5·1	4·2	4·7	4·2	3	—	2·9
Width of spur over flanches in inches	21	21	24	21	17	20	26
Thickness of rim of spur in inches	6	6	7	5·5	2·5	3	3
Number of teeth in spur wheel	49	33	49	33	25	—	26
Diameter of fly wheel in feet	13·5	16	18	15·3	12	16	16
Sectional area of metal in rim of fly wheel in inches	144	144	144	144	108	144	144
Diameter of fly shaft bearings in inches	12	12	12	12	8·5	9·5	9·5
Weight of metal on fly shaft bearings in tons	25	26	30	24	11	24	21
Revolutions of fly wheel per minute	53	68	61	71	114	68	70
Number of trains driven by engine	2	2	2	2	2	1	1
Revolutions of rolls per minute	53	68	61	71	56	69	70
Number of puddling furnaces to each forge	16	16	16	16	12	18	11
Diameter of shear spindle in inches	8	10	8	8	8	—	—
Cuts of cropping shears per minute	54	22	41	59	57	—	70
Weight of engine framing under level of crank shaft standard } In tons }	46	48	216	94	22	37	43
Number of boilers to engine	3	3	3	4	2	2	—
Description of boiler	Cylind.	Cylind.	Cylind	Cylind.	Cylind.	Hemis.	—
Pressure above the atmosphere in lbs. per square inch	28	28	50	62	75	7	7
Square feet of boiler surface exposed to the heat	1900	1134	60	1296	648	700	700
Area of fire grate in superficial feet	142	156	142	220	112	200	112
Consumption of coal per 24 hours in tons	9·5	9·3	10	14	8	9	—
Consumption of coal per ton of puddle bars made by forge in cwts.	2·8	2·6	2	2·7	3·4	3·6	—

Section XVII.—The manufacture of malleable iron.

The conversion of the puddle bar into the various forms of finished iron met with in commerce, is done by heating in reverberatory furnaces commonly termed "balling furnaces," and roll-

ing into bars of the desired section and length; into malleable iron plates; and into pipes.

The balling furnace is very similar to the puddling in construction; it has a chimney of like dimensions; but, is generally 8 or 9 inches wider, and 2 feet longer in the body part of the furnace, for working the larger sizes of bars. The fireplace averages 12 feet in area. The cast iron bottom is laid 13 or 14 inches below the working door; on the plate a sand bottom is laid, falling from the door to the back of the furnace, and from the door to the flue. Between the body of the furnace and the fireplace a brick bridge 9 inches thick is carried up to within 14 inches of the arched roof; at the flue end the sand bottom is gradually rounded off to meet the floor of the vertical flue. The iron bottom, though in general use, is not necessary; by carrying up the bridge from the bottom of the ash-pit, the inside space may be filled up with any convenient material to a level for the sand bottom. A stock hole, working door, and damper, complete the requisites of a balling furnace.

A number of puddle bars of a suitable length, generally 3 to 4½ feet, are placed together to form a "pile," the sectional dimensions of which varies with the order from 3 inches square, a small size, to 12 inches square, a large size. If they are made 3½ feet long, 7 inches wide, and 8 inches high—a common size for railway bars and the larger kinds of merchant iron—the baller charges 4 at a time for a "heat," by placing them singly on a flat iron bar, called the "peeler," and sliding into the furnace, taking care, however, not to disturb the arrangement of the bars. When charged, the piles will lie nearly across the furnace, radiating from the door, the ends towards the back lying 6 or 8 inches lower than those nearest the working door.

The working door is now shut, and some fine coal dusted around its edges to exclude the cold air; the damper is opened to its widest, the grate cleaned of clinkers, fresh fuel added, and the fire urged to the production of an intense heat. After charging, the baller's chief occupation is watching the piles, that they are equally heated, and turning them to expose the underside to the flame and reflected heat of the roof, that the whole may be brought to a uniform welding temperature in the least time. When approaching this point a portion of the iron is oxidized, and combining with the earthy matter it forms a cinder, which flowing over the surface of the pile protects it for a brief period from the farther action of the air. If the operation is unnecessarily prolonged the flow of cinder ceases, the iron suffers from the oxygen of the air, loses its tenacity and property of welding, and cannot be manufactured into a finished bar.

With a heat of 4 piles of the above dimensions the time occupied, in heating, when properly conducted, will average 6 minutes; they are now grasped with a pair of heavy tongs and

dragged on to a carriage for conveyance to the rolls. The drawing out, charging fresh heat, and repairing any damage that may have occurred to the sand bottom, will average 16 minutes per heat. Piles of this size weigh about 4 cwts. each; consequently at this rate of working a balling furnace heats 36 piles in the 12 hours, or 83 tons of iron per week.

For the smaller sizes of merchant bars, the piles are made about 18 inches long, 3 inches wide, and 2½ to 3½ inches high. The heat is composed of 16 or 18 piles, which are from 28 to 30 minutes in heating to a welding temperature. Time occupied in drawing out the heat, charging, and repairing, averages 21 minutes per heat. At this rate of working a furnace heating piles of this size heats about 31 tons weekly.

The smallest merchant bar iron is rolled from solid bolts of manufactured iron termed "billets," measuring 12 to 20 inches long, by 1¼ to 1¾ inches in their minor diameter. Smaller balling furnaces are employed, and from 30 to 40 billets heated at once. To economize time and diminish the waste of iron by oxidation, which otherwise would be very great with the smallest sizes, cold billets are charged as the hot are withdrawn. Furnaces working on billets for guide iron, heat from 15 to 25 tons a week, according to the size and length of the finished bars.

YIELD.

The reduction of weight which occurs during the heating process is dependent chiefly on the skill of the baller, but is influenced by the character of the coal and state of the furnace. With care and a fair average quality of iron, the loss will not exceed 80 lbs. per ton on the large piles, 130 lbs. on the smaller sizes, and 210 lbs. on the guide rolled iron. The yield, or consumption of puddle iron, to produce one ton of finished iron is ordinarily much greater than this, but we have ascertained, by weighing before and after heating, that perfectly sound bar iron may be produced with this loss.

The consumption of coal in heating the large piles averages 7 cwts. to the ton of iron charged; in the smaller sizes 10 cwts.; and in heating the guide rolled iron 13 cwts.

PILING.

The formation of the pile in the arrangement of the pieces, their size, weight, and quality, is a subject of much importance in the manufacture of sound bar iron. The form of the finished bar and the purpose to which it is to be applied, require to be carefully attended to in the piling, together with the local character of the iron about to be employed.

A rail pile for the common qualities of rails is usually composed of a bottom piece of No. 2 iron, 6 or 7 inches wide by 1 inch

thick; on this plate of superior iron 18 or 20 pieces of puddle iron, 3 to 3½ inches wide by ⅝ thick are laid, and capped by a second piece of No. 2 iron of the same size as the first. If intended for flanch rails, square bars of soft iron are added to the plate of No. 2 to form the flanch. The iron for these bars is worked for the purpose from a burden containing little or no hematite or refinery cinder. Thin and broad flanch rails cannot be worked unless attention is paid to the disposition of the iron in the pile, and the presence of a very soft tenacious iron in the flanch ensured. The strain thrown on the flanches by the superior diameter of the rolls at the body dragging the thin portion through, is sufficiently great in the finishing grooves to tear them from the body of the rail. In heating, also, care is required that these bars are not over heated.

The length of the pile is proportioned to the length and weight of the finished rail bar; the weight considerably exceeds that of the rail, for in addition to loss in the heating process, allowance is required to be made for the portion cut off each end. Where great exactitude in length is demanded, and the entire order is cut to one uniform gauge, the weight of iron in the pile exceeds the weight of the rail in the proportion of 5 to 4; but where a portion of the order is cut to a shorter length, the allowance for crops and loss is largely diminished.

If the rail is large the process of shaping the bar is commenced in the pile, which is made of a diminished width at the head; and in the case of rails in which the balance of metal is unequally distributed, a similar course is frequently pursued.

For double-head, bridge and other varieties of railway iron, the common pile is employed, with such quantity of superior iron, as the specification requires, or the manufacturer deems necessary.* A portion of the centre is frequently made with pieces of rail bars cut in short lengths for re-manufacture. In consequence however of the irregular section of the rails, they do not pile well with the flat bars; and to render the pile more solid, puddle bars are rolled of such sections as will, in combination with the rail pieces, leave no interstices for the lodgment of cinder in quantity.

* The principal purpose to which wrought bars are now applied is the fabrication of railway iron. Of late years English Railway Companies have been in the habit of minutely specifying the qualities of the iron, its arrangement in the pile, length and thickness, and mode of working. The railroad engineer, whose acquaintance with the subject necessarily must be very limited, dictates to the experienced manufacturer the plan to be pursued in the manufacture of the bars. A superior quality of rail is supposed to be ensured by thus specifyng the mode of manufacture. Railroad Companies, however, commit a serious error when they undertake to define the most advantageous section of pile and mode of rolling.

In the first place, by specifying that certain proportions of No. 2 and No. 3 iron form the pile, they treat the local appellation of 1, 2, and 3 as defining irons of particular quality and value, instead of being as they in practice are, convenient terms used by the manufacturer to distinguish iron that has been rolled this

In the manufacture of merchant iron-bars of No. 2, or common quality, the pile is composed altogether of bars of puddle iron laid one on the other, when the height does not greatly exceed the width; for larger piles a double width of bars is employed; in all cases, however, a rectangular pile of bars is built.

The piling for No. 3 iron is performed with short lengths of No. 2 bars laid in the same manner as puddle bars for common iron. No. 3 iron is consequently superior to No. 2, inasmuch, that, it has undergone an additional re-heating and rolling. By going through this additional process, the fibre, and general quality of some irons are considerably improved, but in other irons the cost and waste of this process is not attended with corresponding advantage to the commercial value of the finished bar.

To augment and develope the fibre in the manufacture of particular orders, the pile is made short and disproportionately thick, that, in the subsequent greater elongation by rolling, the iron may be of a dense fibrous character. For this purpose the short thick pile is evidently superior to others, but it is attended with the disadvantage of requiring a longer time to thoroughly heat; the outside is generally burnt before the interior is brought to a welding temperature. The resulting bar iron, therefore, is not equal to that produced with a longer pile; it is rarely sound in the centre, and if its tensile strength is tested, it is discovered that the over heating and long exposure of the exterior has diminished, instead of increased its strength.

In the manufacture of large bolts the piling is sometimes done

number of times. The quality of the iron is modified, but not determined by the number of re-heatings and rollings. The No. 2 of one manufacturer may surpass in strength, fibre, and other qualities the No. 3 of other makers; and in the fabrication of railway bars may be quite as advantageous as the higher denomination. But the railroad companies require the extra process to be gone through, which entails so much additional expense that the superior quality cannot compete in price with the inferior No. 3. Hence, by defining the qualities to be used, the railroad companies unintentionally secure for themselves the inferior rails which they are so anxious to avoid.

In the second place, when a specification of the iron to be used and mode of working accompanies the order for the rails, their manufacture is reduced to a contract to supply according to such specification; and the maker is released of all responsibility respecting the fitness and sufficiency of his irons for the purpose. The manufacturer therefore prefers working under a specification, for, by adhering to the stipulated conditions; should the bars eventually wear badly, or otherwise prove defective, he is absolved from blame. The continental roads constructed under the superintendence of local engineers adopt a more rational course with the manufacturer. They stipulate that the finished bar shall bear certain tests without injurious deflection or opening of the fibre, leaving to the judgment of the manufacturer the quality of the iron used, and mode of working best calculated for the attainment of these tests with the least expense. By thus stipulating for the presence of certain qualities in the finished bar, the manufacturer is compelled to use such irons, and adopt such modes of working it as will ensure their sufficiency.

by placing a number of bars of a wedge-like section radially around a central bar, forming a cylindrical pile, kept together by thin iron bands. It is heated in the balling furnace, and rolled into a bolt of the desired diameter and length. By mechanical engineers this mode of piling is supposed to ensure a more solid bolt than the ordinary rectangular pile of flat bars. In practice, however, we find it difficult to produce a sound bar when the pile is thus constructed. The central bar receives its heat by conduction from the radial bars; these are elevated to the welding point long before the centre bar can be in that state, and since their continuance in the furnace, after arriving at the welding temperature, is attended with deterioration of quality and loss of iron from oxidation, the pile is drawn before the central surfaces have arrived at a proper temperature. Passed between the rolls the exterior radial bars are firmly welded to each other at their circumference, but very rarely through their entire depth; the central bar is consequently elongated with the general distension, but is not welded to the others. Having noted the manufacture of several heavy bolts on this plan, in no instance in the subsequent working of the iron by the smith, did we find the centre welded to the exterior bars. When used as shafting, a severe twisting disconnected the pieces, and displayed the centre bar detached from all the others. For piston rods and other purposes employing the tensile property alone, the imperfect weld is not generally seen; but in the case of 4 piston rods that broke under our inspection, the existence of the centre bar intact was made manifest.

For certain varieties of iron fagotted piles are employed. They are formed in different ways, by forming a box pile of iron plates, and filling the interior with clippings of plates, old chains, or other scrap iron, heating and then rolling, or what is preferable, hammering well under a heavy hammer, and re-heating before rolling. The hammering greatly improves the quality of scrap iron.

Angle iron, tram plates, and T iron are usually rolled from piles having a portion of the puddle, or No. 2 iron if for best qualities, cut short and laid across the pile. If for angle iron the top and bottom pieces are laid longitudinally, and the centre of the pile built of layers of transverse and longitudinal bars alternately. The power of the iron to resist a lateral strain is increased by cross piling, while the general quality is more homogeneous.

Bars for re-manufacture into tin plates are required to be of good quality, seldom under best cable; the piles are usually built as for ordinary bars, but some makers require them to be built with layers of bars laid cross-wise. Plate iron which is to be manufactured into hollow ware and Birmingham goods, known by the rollers as "black plate," is piled in a similar manner.

Large quantities of tinned iron plates have been made from rail ends and mill crops, but such plates cannot be moulded into the more intricate forms of tin ware.

Boiler plates if manufactured of best iron are invariably rolled from piles having alternate layers laid cross-wise. A cheaper method, largely adopted in Staffordshire, consists in combining two blooms, previously slabbed between rolls, re-heating and rolling direct into plates. As the blooms are void of fibre, the distension of the plate in both directions in rolling, results in the production of a plate equally strong in either direction. The quality, however, cannot be rated so high as No. 2 iron, whereas boiler plates should never be under No. 3. In the manufacture of such plates, in fact, too much care cannot be taken in the selection of the crude iron and in its subsequent conversion into bars, and finally into plates.

We are of opinion that cross-piling, to a great or lesser extent, is advantageous in the manufacture of railway bars. In some experimental trials made with bars rolled from piles which had one or more layers at right angles, the stiffness was largely increased, and the metal when broken for examination has the appearance of cast steel. By attention to the position of the cross pieces in the pile, rails were made from a single quality of iron, on one side soft and fibrous, on the other side hard and crystalline.

MILL HAMMERS.

Hammering certainly improves the general quality of most bar irons. The rapid consolidation under the blows of a heavy mill hammer, expels the cinder while the metal is at a sufficiently high temperature for its escape. If this operation be omitted, the pressure exerted on the pile during the rolling forces out a portion, but in consequence of the rapid reduction of temperature in the finishing grooves, the remaining cinder is wrapped up in the iron. Hammered iron is more homogeneous, has a greater specific gravity, and is superior in point of strength; in the manufacture of the best qualities this operation should never be omitted.

The mill hammer is very similar to the forge, but for a mill working the larger sizes of bars the helve weighs from 7 to 8 tons. The hammer face is cast to the helve, and measures about 4 feet by 18 inches; the anvil face measures about 4 feet by 2 feet. With the heavy gearing necessary for communicating motion, the mill hammer and connections will weigh nearly 60 tons. From 12 to 20 blows are given to the pile, averaging from 10 to 18 seconds of time.

The steam hammer has been employed in mills, but for the purposes required by the ironmaster it possesses no superiority over the common hammer. Where a great range in the force of

the blow is required the steam hammer stands unrivalled; in manufacturing bar iron, however, the blooms are required to be hammered with a maximum force throughout. Hence, the steam hammer is little used in the manufacture; a common mill hammer, costing only one-fifth as much, being equally as efficient.

ROLLING BARS.

The train of mill rolls for large iron consists of two pairs,—one for roughing, generally about 6½ feet between bearings, and 22 inches diameter; the other for finishing, about 3½ feet long by 18 inches diameter. The standards, spindles, and connections require to be as strong as those at the puddling train. The finishing roll standards are furnished with several adjusting and tightening screws for setting and maintaining the rolls in their position. Motion is communicated to the finishing rolls by a pair of pinions and leading spindles; from the bottom finishing a coupling spindle communicates motion to the bottom roughing, and by nuts keyed on the end of this pair to the top roughing roll. Driving the roughing rolls by connection with the bottom finishing only, permits at any time of larger roughing rolls being used—an advantage in rolling large orders.

Railway bars are rolled with rolls having flat and edge grooves alternately. The pile is first passed with the bars of which it is built on their flat; in the succeeding groove of diminished size, the pile is turned on its side and passed through with its bars edgewise. The first four or five grooves are flat-bottomed, diminishing slightly in width as they deepen, that the pile may freely deliver itself during rolling. The sides and bottom are notched to catch the iron; but if large rolls are used and the draught well proportioned, the necessity for notching the rolls—an operation at all times to be avoided as much as practicable—is much reduced. For the ready admission of the pile in turning the rolls care is required that the width of the pile is inferior to the groove; and that in the succeeding grooves the breadth is not greater than the height of the groove through which the pile has just passed. The flat-and-edge system is probably the most expeditious mode of rolling that can be adopted. The pile requires less handling by the roughers, is lifted back more readily by the hookers, and at all times lies flat on the rollers of the rest. Diamond shaped grooves formerly were much used in rail rolling, and the gothic form also was used, but to a less extent.

Merchant bars are rolled with roughing rolls having flat-and-edge grooves, but the diamond or the gothic produces the most satisfactory results. The first groove is usually flat-bottomed, followed by others of a diamond or gothic section. Grooves of the latter section are deemed superior to the former, and are gen-

erally used in roughing rolls for both light and heavy merchant bars. Bolts cannot well be rolled with other than gothic grooves. In their formation the same principle as is followed in the flat-and-edge groove is observed, the breadth of a groove being greater than the height of the preceding one.

In the roughing rolls of the guide train, flat, gothic, and diamond grooves appear on the same roll, and frequently others of an oval section are added. The billet or pile to be rolled, and the section of order in hand, principally determines the form of groove to be used.

The finishing rolls of a rail train are turned with three to six grooves, the last or finishing being the transverse section of the rail bar when hot. The allowance to be made for contraction in cooling depends on the rate of working and the local character of the iron; with iron from argillaceous ores, and rolls revolving 85 to 90 times per minute, $\frac{1}{4}\frac{1}{8}$th to $\frac{1}{3}\frac{1}{0}$th is sufficient. Flanch rails are, in this respect, the most difficult to manufacture accurately to section.

Finishing rolls for flat bars are made with flat-bottomed grooves, but owing to the necessity of delivering the iron freely, their sides are not parallel; the bottom of the groove being narrower than the top; the reduction of width amounts to from $\frac{1}{3}\frac{1}{0}$ to $\frac{1}{2}\frac{1}{0}$th of an inch for each inch in depth. In consequence of this taper in the groove, the sides of the finished bar do not form right angles. The deviation is diminished by reversing the bar in the last groove, and passing it once through with the upper side, the widest down in the bottom of the groove. In thin bars the tapering form of the groove is scarcely perceptible; in the thickest bars it is very apparent.

Square bars are produced with rolls having diamond shaped grooves sunk on their surface. At the bottom the two sides of the groove form a right angle, continuing so for about half the depth, when they spread to from $\frac{1}{2}\frac{1}{0}$ to $\frac{1}{1}\frac{1}{8}$th of the major diameter of the bar. In the construction of the finishing rolls for square bars the same principle is followed as in the formation of the gothic grooved roughing rolls; the depth of the groove formed by the junction of the rolls being less than the width of the succeeding smaller groove. This, in short, may be stated as the fundamental principle of rolling. The breadth of the groove at all times is in excess of its depth: if the diameters were equal, the pile could not, as is now done, be reduced from a square of six inches to one of 2 inches by a revolving pressure. To arrive at the reduced dimension the pile is passed through a number of grooves, each of a sectional area less than the preceding, but of inferior dimension in one diameter only. The rolls compress the iron by a vertical pressure, they have no power laterally, consequently the reduction is thrown on the bottom of the groove. At each rolling the depth of the pile is diminished, the difference in section between successive grooves is technically termed

the "draught." That the iron may be compressed laterally the pile is turned partly around at each succeeding groove, so that the horizontal becomes the vertical diameter on which the rolling pressure acts.

In rolling squares the bar is passed through two or three grooves in the finishing rolls of a larger size before entering the last; a portion of the reduction in all cases being effected in the finishing, the bar in each succeeding groove being turned over one side of the square; through the last it is passed three or four times and turned at each repetition in order to ensure a perfectly square bar. If passed only once through the last, as in the previous grooves, the finished bar would possess nearly the same section as the groove, which is of a diamond form measuring considerably more on the horizontal than on the vertical diameter.

Large bolts are rolled with rolls having grooves approaching a semi-circular section sunk on the surface; at the bottom they are curved to the radius of the hot bar which they are intended to produce; at the surface of the roll the width is augmented from $\frac{1}{8}$ to $\frac{1}{16}$th of the diameter of the bar, the horizontal distension of the grooves being nearly similar to that in rolls for square and gothic bars, and is greater or lesser, according to the rapidity of reduction. The rolling of bolts of a large size with present appliances, is probably the most laborious operation connected with the rolling of iron. The bolt is passed through the finishing groove five or six times, in order to attain a cylindrical form, for, owing to the lateral distension of the grooves, the bar as delivered by the preceding groove is of an oval section, and being placed with its longest diameter vertically, has a tendency during the rolling to turn on its axis to the horizontal position; to prevent this the end is tightly grasped with several pairs of heavy tongs, held by the roller and his assistants, and maintained in the vertical position until nearly through, when it is released. In the next rolling it is turned partly around to still farther reduce the inequality in its diameter caused by the peculiar form of the groove; the rolling through the finishing groove is repeated, until by gauging, the bolt is ascertained to be of a truly cylindrical form throughout.

The smallest bolts are produced in a different manner from the foregoing. The iron, by passing through a series of oval and diamond shaped grooves is reduced to an oval bar, equal in sectional area to that of the bolt to be manufactured. Grooves of a semi-circular section are turned on the surface of the finishing rolls, forming when combined in pairs, complete circles. The oval bar is inserted between iron guides, which maintain it in the vertical position, while the rolls violently compress the iron to the cylindrical form by one operation, requiring no farther rolling. Great nicety is required in proportioning the oval

to the circular groove. If the area of the former is in excess of the latter, the surplus iron is forced out at the junction of the rolls, forming a thin film at each side of the bar. On the other hand, if it is inferior in section, the iron when compressed will not suffice to fill up and complete the circle.

Guide rolling appears to be confined to the smallest sizes of bolts, up to ⅝ inch diameter; for larger sizes it is rarely used. The great alteration of section effected at one operation, at a stage when the iron is comparatively cold, doubtless deteriorates the quality. Hence, for guide rolling we find that it is only iron of a superior quality that can successfully stand under the crushing action of the rolls, in reducing the oval to the circular section; inferior iron rolled into inch bolts were deemed greatly inferior in quality to other irons rolled in the ordinary way by hand.

Small merchant bars are usually rolled of a great length where a sufficiency of power for the purpose exists. Formerly 20 feet was considered sufficient; now 50 feet is not an unusual length; the bar being subsequently cut in two or three. The rolling long bars is advantageous in many respects; the yield is better; the loss from crop-ends is reduced in the same ratio as the length is augmented; the make is increased, while the labor expended remains nearly the same.

The diameter of the top rolls for squares and bolts is greater than that of the bottom, in the proportion of 61 to 60. This larger diameter of the top roll is necessary in order to throw the iron down on the guides; making the same number of revolutions per minute, the circumference of the upper roll travels over a greater distance, which tends to deflect the point of the bar. In the roughing pair the diameter of the top is to that of the bottom roll as 51 is to 50. Rolls for flat bars are turned with a similar difference in their respective diameters; the dimension being taken at the part of the roll which compresses the iron. In the turning of rail rolls the increase is made on the mean diameter of the roll at the working surfaces.

The speed of the mill rolls varies greatly in the different iron-making districts. The English mills are driven at a much slower rate than the Welsh. In Staffordshire and Yorkshire 60 revolutions per minute may be considered a maximum velocity at the rail and large mills. In Wales this is a minimum velocity, few of the mills bing driven at a less speed than 70 revolutions per minute, while the majority are kept running at from 100 to 110; at the latter speed the circumference of the rolls travel from 515 to 576 feet per minute. When rolling large bolts the speed is greatly reduced, during the period which the bolt is in the finishing rolls less than the one-half of the rail rolling speed being maintained. The smaller merchant iron mills having 12 inch rolls are driven from 110 to 130 revolutions per minute, or from 346 to 408 feet. Guide rolls 8 inches in diameter, 220 to 280 revolutions, or from 460 to 586 feet per minute.

The character of the iron is to be taken into consideration in setting the speed of the rolls. If of a red-short nature a maximum velocity is necessary, in order to produce flanch rails sound on the surface; but if of a cold-short tendency a reduced velocity will suffice. Where boiling the pig iron is largely practised in Wales, and the red-short tendency of such iron farther heightened by double heating during the process, the rolls are driven at the highest practicable working velocity. In rail mills, as at present constructed, there is a limit to the speed attainable; if this speed be exceeded, the time lost by the roughers and roller in seizing the bar is more than that saved by the higher working velocity. As a general rule, inferior qualities of iron work best with a high speed, at low speeds they are seldom worked successfully; superior qualities, however, may be advantageously worked at comparatively high as well as low speeds. We have seen excellent cable iron rolled at 35 revolutions per minute, and 45 to 50 revolutions is near the average speed at mills working entirely on the best qualities.

In the ordinary rolling mill the rolls are driven constantly in the same direction, the bar being lifted over the top roll back to the roller to enter the succeeding groove. A few instances have occurred wherein the motion of the rolls has been reversed, and the bar passed back through the succeeding groove. The advantages which result from the reversing motion over these obtained in the old plan of rolling are not very apparent. It is applicable only to mills running at a very slow speed; the sudden reversal of these driven at 100 revolutions per minute would be quite impracticable. It is a question if the time lost in the reversing is not equal if it does not exceed that lost in passing the bar back over the roll. The number of men employed at a train is increased, rather than diminished, while the greater first cost, and the liability to accident is increased by the additional spur gearing and connections necessary for reversing.

To economize time, in the rolling of the smallest bars, which otherwise would become comparatively cold before finishing, the guide and small merchant bar trains are furnished with three rolls to each pair of standards, the three being geared together by pinions; the bottom roll and lower side of the middle roll reduce the iron in the forward motion, while the top roll and upper side of the middle roll work in a contrary direction, and the bar is returned between these for reduction in the backward motion. The three-roll movement has been applied to rail and other large mills, but its most prominent advantages are limited to trains of small rolls.

The reduction of the pile into a bar at one movement, by passing through a series of single groove rolls, placed in advance of each other, has been experimentally tried, but without success. In the rolling of large quantities of iron in the same sec-

tion, the plan, if practicable, must result in a large saving of labor, and enable a train of rolls to produce an almost unlimited quantity of bars weekly. The practical application of the principle, however, is attended with no ordinary difficulties. The circumference of each succeeding pair of rolls is required to travel with an accelerated velocity; the velocity being in an inverse ratio to the sectional area of the bar in such rolls; a point which has to be determined with the greatest accuracy, and maintained unaltered. If the pile measures six inches square, and the finished bar two inches square, the sectional area will be reduced from 36 to 4 inches; hence, the velocity of the rolls containing the finishing, is required to be 9 times that of the rolls containing the entrance groove. This difference of speed, which has to be met with suitable gearing, of adequate strength, results in the first cost of the train being trebled or quadrupled, and the difficulties and cost of maintenance to be enhanced in the same ratio.

The rolling of boiler plates is conducted on principles different from these followed with bars. The plate rolls are of a plain cylindrical form, turned of the same diameter on the body; and to increase their durability, are invariably cast from ascertained qualities of iron in thick iron chills, thereby imparting to the surface metal hardness and brittleness little inferior to that of tempered cast steel. The standards are constructed of cast iron, with large wrought iron screw-bolts reaching up from the bottom, and provided with large nuts on the top riders. Levers are generally employed for balancing a portion of the weight, and lifting the top rolls completely off when necessary during the rolling.

The pile for plates is made wider, shorter, and generally thinner than for bars. It is taken from the heating furnace, and passed side-wise between the rolls, afterwards it is passed end-wise, changing the direction at each rolling until reduced to near the desired thickness and size, when it is handed over to the finishing rolls. The dimensions and thickness are now roughly ascertained, guided by which, the roller passes it between the rolls end-wise or side-wise, according to the direction in which the greatest elongation is required, taking care, however, that the elongation in both directions be such, that, when reduced to the ganged thickness the finished plate may be sufficiently large to cut to the dimensions ordered.

In working the best boiler plate, the piling and rolling require to be carefully adjusted to each other. The length and breadth of the pile should be to each other as the length is to the breadth of the plate to be rolled from it. The bars composing the pile should be equally distributed, across and along its length. If care be taken in the rolling, the plate when distended to the full dimensions, will be equally strong in any direction that it may

be tested. By attention to these points the manufactured plates will not possess the too common defect of being stronger in one direction than in another. Experiments have been made with a view of determining the strength of the iron composing boiler plates; and by noting the weight necessary to pull asunder strips cut across, and comparing the results with those obtained with others cut length-wise of the plate, a considerable difference is observed. The iron has the least strength when pulled in a direction at right angles to the greatest distension by rolling. If the variation in strength is considerable, it is conclusive evidence that the plate has been improperly manufactured.

In a published account of some experiments by Mr. Fairbairn, the strength of the plate is stated to have been greatest when pulled at right angles to the grain of the iron. This is an error, and probably arose from a mistake as to the direction of the grain; for a mere inspection cannot determine its direction. The form of the pile, position of the iron composing it, and the direction of distension at each successive rolling, require to be noted during the manufacture, otherwise we are unable to state in what direction the grain of the iron lies. It is in the power of the roller to produce from a given pile plates having the grain of the iron at right angles to their length, or running parallel. The roller can also vary the direction of distension so as to produce from a pile built with the grain of the iron disposed in one direction, a plate void of fibre and equally strong in every direction.

Long plates for shipbuilding generally possess the grain running with the length, but by an alteration in the pile they may be rolled with little fibre and of nearly uniform strength. In the long plates, however, it is not in the power of the roller to change the direction of the grain. The operation of rolling is very similar to the rolling of bars, the distension is greatest longitudinally, hence in this direction the grain lies. If piled with the major portion of the iron across the pile the distension of these pieces laterally neutralizes the tendency to form fibre.

Tinned iron plates are rolled in a similar manner, and the same attention is demanded to ensure the production of a uniform strength and quality.

Nail rods are produced by rolling a small pile between flat grooved roughing rolls, and, after distension laterally to a stripe about 6 inches wide, and of the thickness required for the gauge of rod produced, by rolling between plain cylindrical rolls of the hardest quality, passing through revolving cutters which shear the strip longitudinally into the required number of rods. The number of cutters on each spindle varies with the order under manufacture, from 3 to 10; the strips formerly were rolled for the production of only one length of rod, but in the more recently erected mills they are rolled of a sufficient length to cut

three or four rods lengthwise, producing, therefore, from each pile from 20 to 76 nail rods. The cutters are composed principally from wrought iron edged with steel, and to prevent softening by the heat communicated by the strip, are kept cool by a constant flow of water from a grated cistern fixed across the standards.

Hoops are produced by rolling a pile or billet between roughing and intermediate rolls, into a rod of the requisite sectional area, and finishing by distention laterally to the required width between plain cylindrical rolls.

Iron of a tapering form, or otherwise varying in thickness, is produced by regulating the escape or influx of water, or other fluid in a cylinder, allowing the top roll to rise or compelling it to fall at the rate required to produce the desired alteration of thickness. The same object may be attained by the application of suitable gearing to the head of the ordinary tightening screw, and the communication of motion at the entrance of the bar. In either case, however, the production of bars of varying thickness necessitates the employment of rolls independent of the usual train in which the final alteration of thickness is accomplished.

Figured devices on the surface of the iron bars of varying width, and bars with countersunk holes on the surface are produced by letting in the rolls at the finishing or last groove, corresponding steel dies and punches. Trade marks are produced in a similar manner, though the older mode of hand stamping is most commonly followed.

FLUE DAMPERS.

Balling and puddling furnaces are occasionally built with dampers at the bottom of the chimney stack; when in a vertical position it fills up the opening in the brick-work leaving an unobstructed passage for the draught, let down it rests against the opposite side of the flue in a diagonal direction, completely closing it and opening the portion above to the atmosphere. The damper, in such cases, is placed immediately above the take up, on the iron framing under the brickwork of the chimney; in width it is about one inch less than the flue; at the bottom it is hinged to a small frame built in the brick-work, and is opened and shut by a lever and balance weight. The back, which at all times is open to the atmosphere, is made of cast iron, protected from the intense heat in front by a covering of fire-clay adhering to spikes cast on the under side of the damper.

The chief objection to this mode of damping, lies in the cooling of the stack by the ascent of a column of cold air, on the draught of the furnace being shut off. The stack is cooled down, and on again opening the damper the reduction of temperature is felt in the inferior draught created; a longer time is required for

bringing the heat to a welding point, attended with an increased consumption of coal, and an inferior make and yield of iron.

WASTE HEAT OF REVERBERATORY FURNACES.

The economical application of the waste heat escaping from puddling and balling furnaces has received much attention from iron-masters, but it is questionable if the subject is rightly understood by the majority of those interested. A common plan of economizing the heat is to place a vertical boiler between two or more furnaces; the steam being generated by the heat escaping from the furnaces. In other establishments a powerful chimney is employed to draw down the products of combustion from four or five furnaces and pass them under a large boiler. A third plan is to form the lower portion of the stack into a small vertical boiler with central flue, fitted with safety apparatus, feed and steam pipes.

That steam can be obtained from boilers so situate there can be no question, and it is equally evident that a sufficiency may be formed to work the engine without the employment of separate fires for the purpose. It is, however, a problem for consideration, whether the saving of engine coal is not balanced by the increased consumption of furnace coal. On two occasions experimental trials were made at the Dowlais works with boilers attached to heating furnaces, for several months on each occasion. The results with these boilers were such as we anticipated. The weekly make of the furnace declined, while the yield of iron was augmented. The consumption of coal in the furnace-grate per ton of iron produced was greater than formerly was required for both furnace and engine; and owing to the longer period occupied in heating, and the inferior temperature attained, the quality was deteriorated. In Staffordshire and Derbyshire, a considerable number of boilers may be seen attached to furnaces, but it is a circumstance worthy of remark, that, in the recently erected works they are not general, from which we infer, that, in practice the results are not widely different from those obtained in the Dowlais experimental furnace.

If a brief consideration be given to the conditions essential to the successful working of reverberatory furnaces the impolicy of attaching boilers is made apparent. The rapid draught necessary to the production of an intense heat can be produced only by a chimney stack of the requisite height, with its internal flue maintained at a comparatively high temperature. If it is cold the drawing power of the chimney is reduced to a minimum; at the high temperature of the heating furnace it is at a maximum. Place a boiler, or other ready conductor of heat in the stack, and the temperature is reduced, followed by an inferior draught and less intense heat in the furnace; if placed near the furnace, say immediately on the cast framing of the stack, the

temperature of the furnace is still farther diminished. In consequence of the facilities afforded for the escape of caloric near the body of the furnace, the temperature necessary for working the iron is attained with difficulty. Where the temperature is produced by a draught we cannot maintain an intense heat in one part of the furnace, immediately contiguous to a part comparatively cold. The cold body has the greatest affinity for caloric, and by a continual absorption, the ultimate temperature of the working portion of the furnace is inferior to that due to the amount of caloric generated in the fire-place. The employment of a blast results in the production of a high temperature without having recourse to the ascensional power of the column of heated gases; but the heat developed by a blast is more limited in its action, and is not sufficiently diffused for the purposes of the reverberatory furnace.

It should be distinctly understood that the heat escaping up the chimney is the motive power which creates the rapid draught; and that the caloric evolved by the combustion of the fuel answers a double purpose;—it heats the charge iron in the furnace to the required point, and by rarefaction imparts to the gaseous column high ascensional powers, without which the development of caloric proceeds too slowly for the rapid action demanded in all operations connected with the production of malleable iron bars. And farther, that, where the area of the fire grate, and area and elevation of the chimney are correctly proportioned to each other, and to the mass of iron to be heated, and the operation is properly conducted, every unit of heat developed is either absorbed in a direct manner by the iron under treatment, or indirectly in creating the necessary draught; and any diminution of the ascensional power of the gaseous column by the abstraction of caloric, reduces the drawing power of the chimney, is followed by a corresponding reduction in the temperature of the body of the furnace, thereby prolonging the operation and augmenting the loss from oxidation. If we deprive the ascending column of the whole of its caloric, the draught is destroyed; if deprived of a portion only, the volocity of ascent, and consequent intensity of the heat maintained is diminished in the same ratio. Hence, in a furnace correctly proportioned throughout, and properly managed, there is no waste heat, and any measures taken for the utilization of the heat of the ascending column, which do not provide for the loss of ascensional power, inevitably results in the efficiency of the fuel used being impaired to a great or lesser extent; when, however, through an erroneous mode of construction, or through improper management, the heat developed is in excess of the quantity required for heating the charge and maintaining the draught, the surplus may be abstracted without injury to the operation; but while the utilization of the fuel thus charged in excess of the requirements of the case may

be desirable, greater economy would be attained, and more science displayed by the adaptation of the furnace to the fuel, and to the mass of iron under treatment.

And it should also be well considered, that, a sharp draught and intense heat are indispensable in working to a good yield of iron. The saving of the entire quantity of engine coal, if attended with an effect on the yield of iron, may be productive of loss instead of profit. The very different value of the two materials consumed, require to be taken into consideration; the iron in the forge and mills may be estimated as being worth £5 per ton; the coal is probably worth 6s. 6d. per ton. The yield of engine coal, where firing under the boiler is practised, averages 2½ cwts. to the ton; the saving of coal, therefore, cannot exceed 10d. per ton; but 18 lbs. of iron are of equal value with 2½ cwts. of coal, and if the iron yield is only this much worse, the saving is reduced to nil. In practice, however, we find the iron yield to be from 40 to 60 lbs. worse when the flue is connected with boilers.

ART. II.—SEARCHING FOR COAL.—BY G. C. GREENWELL.*

THE search for coal is to be differently commenced, according to the state of our information with regard to the locality in which the search is to be made; and this information may be classed under three heads:—

Firstly—Where there is no knowledge of the presence of coal in the district to be explored.

Secondly—Where coal is supposed to exist, being found at some little distance from the locality.

Thirdly—Where coal is worked in adjoining properties.

Firstly—The search for coal in a district where we have no information respecting its existence should be commenced by a general survey of the aspect of the country—of the nature of the strata where exposed by the intersection of ravines, and in the rocky beds of rivers and streams. It will be seen by reference to engraved sections of coal strata that, next to the appearance of coal itself, the occurrence of thin sandstones, and soft and dark-colored shales containing fossil land plants, the bark of which

* A Practical Treatise on Mine Engineering, by G. C. Greenwell, Colliery Viewer, Member of the North of England Institute of Mining Engineers—Newcastle-upon-Tyne, M. & M. W. Lambert.

we find converted into coal, forming what are termed coal-pipes, is most encouraging; but that if, instead of these, strata of chalk or the newer formations are met with, we cannot expect to find any true coal, unless at enormous depths below the surface; or, if we should observe limestones containing trilobites, or even abundance of apparently coal shales, but entirely free from land plants, we may conclude that all labor bestowed on the search for coal will be entirely fruitless. We must also examine the waters of springs, an ochry deposit being a frequent indication of the neighborhood of the carbonates of iron accompanying coal; but this is not by any means to be relied on, as a similar deposit is often thrown down from water issuing from certain clays, as well as from peat bogs.—*Williams' Mineral Kingdom.*

The outcrop of a seam of coal is not unfrequently indicated by a dark shade on the surface of the ground, especially after recent ploughing; and a similar dark shade is often seen under similar circumstances in the clayey banks of rivers or ravines. In either of these cases an examination should be made, the appearance of coal being immediately pursued by an exploring drift driven into the ground or river bank.

If there be a seam of coal, its presence will speedily become manifest. The sooty dark earth will become intermixed with grains or small fragments of coal, which will be found more and more frequent as the drift advances. At last the coal will be found of its full height, still very friable, but of its natural quality. The drift should be continued until the roof is found firm and parallel with the floor of the seam.

It will be fortunate for the party engaged in exploring for coal if the seam found in this manner be of workable thickness and quality; but even should it not do so, it will afford sufficient proof that the country contains coal, the search for a workable seam of which may now be conducted with some probability of ultimate success.

Henceforward the means adopted for proving coal in a district, such as the one in question, apply to that of which our knowledge is imperfect, and we are therefore led to—

Secondly—That case in which the nearest positive existence of coal is at some distance.

In this case we assume it to be known that we have to do with a coal country, an examination of which, with a view to ascertain the direction and dip of the strata, will therefore be the first proceeding.

This may be effected by an inspection of any quarries or cliffs, or by a boring off of the alluvial, commencing where this deposit is of trifling thickness, and must be attended to with care, as a little inaccuracy in the dip, or inattention to any local circumstances affecting it, may lead to very erroneous calculations and results.

To ascertain the angle of dip the clinometer will be found a useful little instrument, and to give results with quite sufficient accuracy for general purposes. It resembles a foot rule, but may be made of any length, with one joint in the middle; it has a bubble tube inserted in its upper edge, and at the joint is a graduated quadrant of a circle. By placing its lower edge upon the bed of a rock in the line of its full dip, and raising the upper edge until the spirit-level denotes it to be horizontal, the angle of inclination may be observed on the quadrant.

The object in obtaining the direction of the strata and the angle of the dip, is to furnish data for the pointing out of situations proper for the exploring of the district by means of boring It is immaterial whether we commence operations at the rise or dip extremity of the district in course of being explored; we will suppose, however, that we commence at the rise, by putting down a bore-hole to the depth of say 30 fathoms.

It is evident that no stratum cropping out on the dip side of this bore-hole will be passed through by it, and the depth of the holes being determined upon, say 30 fathoms, the situation of the next one will be just so far to the dip of the first that it may at the depth of 30 fathoms from the surface reach the uppermost stratum passed through by the first bore-hole.

Supposing the dip of the strata to have been ascertained to be three inches to the yard, or one in twelve, and the surface to be level, the second hole will be required at 720 yards from the first, and the third 1440, and so on; but the holes had better be placed nearer together than this, so that if the expected stratum be not found, a dislocation or slip may at once be suspected, and another bore-hole commenced still nearer to number one.

Boring is usually contracted for by a master borer, who finds all labor and materials according to a regular scale of charges, which at present is as follows:—

For the first 5 fathoms,	. .	£0 7*s* 6*d*	per fathom.
" 2d " "	. . .	0 15 0	"
" 3d " "	. . .	1 2 6	"

and so on in arithmetical progression, rising 7s. 6d. per fathom for every additional five fathoms in depth.

The following is the rule for finding the bore-hole at the above prices, the depth of the bore-hole being (say) 60 fathoms. Consider the question as a series in arithmetical progression, whose first term is (5 × 7s 5)=37s 5, and last term 37s 5 multiplied by the number of fathoms divided by 5.

$$\frac{60}{5} = 12, \text{ the number of terms.}$$

$$\left.\begin{array}{l} 12 \times 37s\ 5 = 450 \\ 1 \times 37s\ 5 = 37s\ 5 \end{array}\right\} \text{extremes.}$$

$$\text{and } \frac{450 \times 37s\ 5}{2} \times 12 = £146\ 5s.$$

For boring, however, through very hard rocks, the above price is insufficient, and in the case of magnesian limestone either double the above prices are charged, or the boring is done by day's work, according to arrangement; and boring through what is commonly called whin, is always performed by day's work.

Boring apparatus consists of three principal parts—the head-gear, which always remains at the surface; the tools which pierce the strata, and the rods with their appendages, which connect the tools with the head-gear.

The head-gear commonly used consists of:—

1. A set of shear legs.
2. A jack-roll.
3. Blocks and rope.
4. A brake.
5. Brace-heads.
6. A runner.
7. A topit.
8. Keys.

1. The shear legs or triangles are placed over the bore-hole for the purpose of supporting the blocks by which the rods are drawn out of or lowered into the hole when it is necessary to renew the chisel. It is obvious that the more frequently it is required to break the joints in drawing the rods, the more time will be occupied in changing or examining the chisels, and the more tedious will the operation become, especially as the depth of the bore-hole increases. It therefore becomes of much importance that the rods should be drawn and lowered as rapidly as possible, and to attain this end, as long lengths as practicable should be drawn at each lift.

The length of lift depending altogether upon the height of the pulley above the top of the bore-hole, the length of the shear legs for a hole of any considerable depth should not be less than 40 or 50 feet; and to add to their efficiency, the bore-hole may be commenced by sinking (particularly when the upper stratum consists of gravel or dry clay) a staple of 6 or 8 fathoms, at the bottom of which the man who has charge of the bore-hole may be stationed while working the rods.

There is also another reason for sinking the staple, which is, that in proportion to its depth is that of the bore-hole diminished, a consequence of more importance than appears at first sight; for supposing the hole to be 90 fathoms, the staple saves £52, 17s. 6d. for boring, at a cost of (say) £10 for sinking, the distance to bore being reduced from 90 fathoms to 82, besides diminishing risk, which increases in a much greater ratio than the depth of the boring, and also saving time, the lowest eight fathoms at such a depth being usually of very slow accomplishment.

The shear legs should be made of three good, sound Norway spars, eight inches in diameter at the bottom, and set upon a frame.

2. The jack-roll may be 12 inches in diameter, properly fitted up with a pawl and brake, so as to regulate the speed with which the rods are lowered into the bore-hole.

3. The blocks may be either single, double, or further multiplied, according to the depth of the borehole and consequent weight of the rods; and here we observe, that upon this system, with the increased depth of bore-holes, instead of the means of drawing and lowering the rods being increased in proportion as regards speed, the reverse is the case.

This at once suggests the application of machinery, which, in an easily transportable form, would greatly facilitate the operation of boring, and to considerably greater depths than those usually attained.

4. The brake. For bore-holes of moderate depth, say under 20 fathoms, the boring is effected so far as the railing and lowering of the rods in the act of piercing the strata by means of a brace-head, which is a piece of wood three feet long and three inches in diameter, which passes through an eye in a piece of iron which screws on the top rod: this is called a single brace-head, and by its means two men can bore without any other aid, to the depth of 10 fathoms. A double brace-head consists of two similar pieces of wood, inserted through two eyes at right angles to each other: by it four men may be applied, and a bore-hole put down to the depth of 20 fathoms.

When, however, the hole has reached this depth, the work becomes too heavy for four men, and especially if the depth of the hole is expected to be much greater, it is advisable to set up a brake in preference to increasing the number of arms of the brace-head, and of men at the bore-hole.

A brake is a simple lever made of Memel fir, of the length of 10 or 12 feet; the fulcrum being 18 inches or 2 feet from one end, and having an iron crook attached, from which the rods are suspended by a piece of rope doubled and passed over the brace-head at the top of the rods. The fulcrum of the brake is an iron axle, working in a carriage bolted to its under side.

The operation of boring with the brake is conducted as follows:—Supposing the rods, with a chisel attached, to have been lowered into the bore hole, we have at the brace-head the master of the shaft, and at the brake two men. The men at the brake, by pressing with the necessary weight upon the longer end of the lever, raise the rods; when raised, the master of the shaft turns the brace-head partly round; the men at the brake suddenly detach their weight from the lever, which instantly causes the rods to fall and the chisel to cut into the stratum; again the rods are lifted, turned, dropped, and so on.

After this process has been continued, in the opinion of the master borer, for a sufficient length of time, the brace-head is unscrewed, and a runner, attached to the rope from the jack-roll,

is passed over the top of the rods, and then a topit is screwed on. The two men who were at the brake, by means of the jack-roll draw up the rods as far as the height of the shear legs will allow, when the master borer, by passing a key upon the top of the rod at the top of the hole beneath the joint, takes the weight of the rods at the first point above the hole, the jack-roll men having reversed the rods for the purpose; with another key the rods are unscrewed at this joint, the rope is lowered down again, the runner put over the rod, another topit screwed on, the rods lifted, and the process continued until the chisel is drawn from the hole and replaced by another.

Boring tools consist of—

1. Chisels.
2. Wimbles.
3. Sludgers.
4. Instruments for boring through coal.
5. Bèches.
6. Rounders.

1. The chisel is 18 inches long, and usually 2¼ inches in breadth, and at the cutting edge is faced with the best steel; it weighs 4½ pounds. The borer has several of these: they are used to cut through the strata, and require constant attention and great care that they may be immediately replaced with fresh ones when any of the substance is worn off their sides, so as to diminish their breadth. If this circumstance is not attended to, the size of the hole of course decreases, so that when a new chisel of the proper size is put in it will not pass down to the bottom, and much unnecessary delay is occasioned in again enlarging the hole.

Whilst using the chisel the borer keeps the brace-head attached to the rods in both hands, one placed on each side of the rods, at the same time moving round the bore-hole, so that the chisel may not fall a second time exactly on the same place, the object being to keep the hole perfectly circular and true. An experienced borer can tell to a nicety the nature of any stratum pierced by the chisel, by the peculiarity of the shock, so to speak, occasioned on its striking the rock bored through; it may, however, simply be remarked, that in passing through shale or metal of any description, portions of it are always attached to the chisel when it is drawn to the surface; but that with post or sandstone this is not the case. The rods should be drawn out of the hole and the chisel examined after boring every six inches, supposing the nature of the stone to be such as to permit this process to be made; if, however, as it frequently happens, the stone is very hard, so that probably the chisel may be worn off before proceeding half an inch, it still requires to be frequently drawn to the surface and examined for the reasons mentioned above.

2. The wimble is three feet long altogether, but has the lower 24 inches cylindrical, with a partial covering at the bottom, and an opening up one side for the admission of the bruised material, the covering at the bottom being for the purpose of retaining the core with which this instrument fills when working in the hole. The external diameter must be such as to admit of its following the chisel; it weighs about 12 pounds.

The wimble is also used in boring through clay, for which purpose it is well adapted. It is turned round in the hole, the cover at the bottom, like that of a shell auger, being a little turned down, occasioning the instrument to penetrate the clay.

3. The sludger is also three feet long, of nearly the same shape as the wimble, the only difference in external appearance being, that instead of having an open side, it is closed to nearly the bottom, where there is a clack fixed for the purpose of retaining borings of a soft and wet nature, or for preventing them from being washed out of it in a wet bore-hole.

Sometimes these two last named instruments are used for boring through coal when it is not very hard, and the sludger is often used for bringing up samples of coal bored by the chisel, but left at the bottom of the bore-hole. The wimble is also sometimes used for this purpose, and, in that case, it is a common practice to stuff a piece of clay into the bottom of it, to which the fragments of coal may adhere. Neither of these plans, however, are satisfactory, the samples, when clay is not used, being usually washed away and lost, especially if the hole be wet, and when clay is used, affording no correct indication of the purity of the coal, and of its freedom from bands of shale.

4. An instrument much better adapted for boring through a seam of coal than any of those yet named has been contrived by Mr. George Stott, of Ferryhill, near Durham, a master borer of very considerable experience and great accuracy. Its object is two-fold, namely: to break off the coal in such samples as not only to afford specimens of sufficient magnitude to indicate the quality of the seam, but also its hardness and general appearance. It is formed of cylindrical iron, the body being 12 inches long, of similar diameter to the wimble, and tapering at the top to the point attaching it to the bottom of the bore-rods. The bottom of the instrument is serrated, and has, besides, two cross-cutters at the bottom within the circle, the whole being for the purpose of cutting, and not bruising, the coal, and answering the object remarkably well. Upon the top of these cutters is also a clack, on which the fragments of coal rest after being forced into the instrument; near to its top, in the tapering part, is an oblong movable piece of iron, or door, which is screwed into its place by a screw-key before putting the instrument into the hole, and which prevents not only any water from washing the coal out, but also any fragments of shale or upper strata

from being mixed with the specimens of coal, by being rubbed down into the instrument on its passage out of the bore-hole. After the instrument has been brought up, the door is unscrewed, and the samples taken out.

The difference between the specimens of coal obtained by means of Mr. Stott's instrument and those obtained in the ordinary way is very remarkable—in the one instance, they are in the form of powder: by the former process, pieces of the size of nuts may be procured.

5. The bèche is used when the bore-rods have broken in the bore-hole, for the purpose of drawing out that portion remaining in the hole; it is a hollow cone, 25 inches long altogether, with a cavity extending upwards, 16 inches; it is 1¼ inches in diameter internally at the lower extremity, the internal diameter diminishing upwards to five-eighths of an inch.

When the rods have broken, the part above the fracture is drawn out of the bore-hole, and the bèche screwed on in place of the broken piece; when this is lowered down upon the broken rod, a smart blow is sufficient to cause the hollow part of the bèche to grip the broken piece with sufficient power to allow the portion below the fracture to be drawn out of the bore-hole.

6. The rounder resembles the bèche externally, but is solid and well steeled at the bottom; it is used for breaking off any irregularity which may have been occasioned either by careless boring, or by small pieces of iron pyrites, or iron stone, which may have been too hard to allow the chisel to cut them with the rest of the strata. The rounder, however, is an instrument which should as seldom as possible be found necessary, because in almost all cases, proper care will preclude its introduction: all that is required to be done is to round out the hole continually with the chisel, and not merely to be satisfied with doing this at the bottom of the hole, but to have the rods raised a few inches from the bottom, and ascertain that it is round there; by doing this the hole will always be kept round, and the time lost by drawing the rods and putting in the rounder saved.

The common rods consist of bars of the best Swedish iron, and may be made either of round, or square iron, but the latter is preferable, as it permits the application of the keys for unscrewing the rods throughout the whole length of each piece. The rods consist of lengths of 3 or 6 feet each, one end of which is a male and the other end is a female screw, for the purpose of connecting them together. They are made of different degrees of strength, according to the depth of the hole for which they are required, but on an average are one inch square, and weigh 22 pounds to the fathom. The screw should not have less than 6 turns. There are also short pipes varying from six inches to two feet in length, which are put on at the top, for the purpose of adjustment of the rods to a convenient height. The common

rods being most liable to accident, should be carefully examined every time they are drawn out of the bore-hole, as a neglect of this precaution may occasion much inconvenience, and even the loss of the bore-hole altogether. A great liability to rupture arises from the splitting of one of the sides of the female screw, and the consequent drawing out of the male screw, thus leaving the rods in the hole; the screw itself may also by ordinary wear and tear have its thread worn off, and, becoming in consequence liable to slip, occasion the same result.

Besides the above apparatus there are also frequently required pipes of iron to put into bore-holes in strata of soft clay or sand. When this is the case near the surface, the wimble used in boring through the clay should be of sufficient size to admit of the introduction of the pipes as far as the bottom of the first length bored, which will be dependent on the judgment of the master borer. When it is found that the wimble, on being withdrawn from the hole, cannot from the lateral pressure be at once returned to the same depth from which it was taken, it must be concluded that the sand or clay is of a running nature. No time should then be lost in enlarging the hole from the surface, or, what is better, if the depth be not great, in commencing anew from the surface with a larger wimble, say three inches in diameter, and putting down the hole to nearly the same depth with all speed. An iron pipe, say 10 feet long, having an internal diameter of 2½ inches, is then driven into the hole, and when this has been effected another pipe of similar dimensions is screwed into its upper end, and the driving repeated; and so on until a sufficient number of pipes have been put on to reach the bottom of the bore-hole. If the ordinary wimble be now introduced through these pipes it will have free access to the clay or sand, and after a few feet further have been bored, another pipe may be screwed on, and the whole driven further down. In this manner several fathoms of soft and running material may be bored through. If the thickness of the surface, clay or sand, however, is very considerable, the method here mentioned will not be found sufficient, as the friction of the pipes occasioned by the pressure of the clay, &c., will, in some instances, be found so great, that perhaps not more than 12 or 14 fathoms of pipes can be driven in without their being injured. When this is the case it is necessary to put down the highest part of the hole with a still larger wimble, and to insert pipes of proportionate diameter; then to continue the hole of smaller diameter, putting in another column of pipes of less size, and thus to proceed until the stone head is reached.

If, after having passed through upper strata of rock, a stratum of quicksand should be met with at a considerable depth, the process becomes very expensive, as the whole of the bore-hole will be to enlarge from the surface, and pipes to insert, as above described.

The most difficult case of all, however, is when there is a running stratum near the surface, and another at some depth, and beneath the solid rock, both requiring tubing. When the bore-hole is finished, the tubes may partly be recovered by means of a sort of solid box-key, which is tapered slightly to the bottom, the diagonal dimensions of the bottom of the key being a little less, and of the top a little greater, than the diameter of the tubes, the instrument being in fact the reverse of the bèche. It is also attached to rods having the screws turned in a different direction from the screws of the tubes. When the key is driven down in the uppermost tube, and turned round by the brace-head, it unscrews the tube, and, as in the case of the bèche, the friction is often sufficient to draw the tube to the surface. Many of the tubes are, however, usually lost.

Attempts have been made to substitute cordage for bore-rods, and for moderate depths the plan has been successful. It consists in merely a frame, with a jack-roll and pulley, over which the cordage is carried, a movable clutch fastening the cord to a brake or lever placed alongside for the purpose of raising a heavy chisel attached to the bottom of the cord. When the depth of the hole is great, the stretching of the rope is such as to prevent any of the effect being produced at the bottom of the bore-hole. If the plan is capable of being made perfect, it might, perhaps, be made so by the application of wire ropes. There must be considerable difficulty, however, in keeping the bore-hole round.

Bore-rods of wood have also occasionally been used, with what advantage will be seen by the following:

The boring executed at Besch, on the Moselle, was performed with wooden rods by the aid of a simple lever or brake. From the 24th of July, 1840, to February, 1841, with 243 days' work of 12 hours each, this boring reached the depth of 156 fathoms, 3 feet, 8 inches, through beds of limestone, grit and gypsum. The rock did not waste until at the depth of 154 fathoms, where a bed of running sandy gravel was met with, which obliged them to put down a column of tubes, which were twice required to be brought out in order to be lengthened. The diameter of this hole was 6·3 inches. There is certainly one great advantage possessed by wooden over iron rods, viz. their lightness; because it will be remembered that since the rods are generally immersed in water, their being of any weight at all is owing to the joints, and such other work as is thought necessary to add to their strength. The extra size of the hole is decidedly advantageous, because, in the first instance, if running strata be met with, it allows margin for the insertion of tubing and the subsequent introduction of iron rods; it will also allow much more satisfactory specimens of coal, or whatever mineral may be sought, to be brought to the surface for examination.

It will sometimes happen, that notwithstanding the general disposition of the strata with regard to rise and dip may be pretty evident, yet a stratum or bed of coal found in one bore-hole will not always be proved in the situation where by calculation it ought to exist. This will result in general from the intersection of the district by faults; and since it is of the first importance in the establishment of a shaft for the purpose of working any stratum, that it should be placed so as to have the greatest possible extent to the rise of the water-level from the shaft, every precaution should be taken to define as distinctly as may be the locality in which the winning ought to be made, so as to answer this end. There will probably be, in every coal country, some top seam or seams which have about them sufficiently characteristic marks, to prevent them being mistaken for others, and the best way to attain the object above specified is to put down a series of bore-holes to such top seams. By a judicious management of such borings, no very great expense must be incurred—the cost being well expended if it lead to the prevention of a winning being made in an improper place. Cases, however, have occurred, and may occur again, in which, notwithstanding all this precaution, errors have arisen.

ART. III.—IRON ORES OF NEW JERSEY—GEOLOGICAL OCCURRENCES—PROPERTIES—METALLURGY, &c. By WILLIAM KITCHELL, State Geologist.

IN my last annual report, upwards of eighty iron mines were enumerated and described, all of which are situated in the counties of Sussex, Passaic, Morris, and Warren, and within an area of three hundred and sixty square miles.

Although some of them have been worked for a century and a half, and in early days furnished a very large proportion of the ore manufactured into iron in this country, yet they have been excavated to a very limited extent, many of them containing immense bodies of ore above water-level which may be economically extracted without the employment of expensive machinery.

It is estimated that they could be made to yield, advantageously, no less than one million tons of ore annually for many years to come, which would be sufficient to supply half of the present annual consumption of iron in the United States.

With a view to demonstrating the general character of these

ores, together with their great economic importance, they will be considered briefly in this report, under the two following heads:

I. Geological occurrence and properties of the magnetic iron ores.

II. Metallurgy of the iron ores.

1. *Geological Occurrence and Properties of the Iron Ores.*—The different forms in which magnetic iron ore occurs in this district, are as follows:

First, in granules disseminated through the gneissoid rock as one of its necessary constituent minerals. The granules vary in size from particles so small that they cannot be seen with the naked eye, to grains corresponding in size with the other constituent minerals of the rock.

Second, in masses or bunches of very limited extent. This form generally occurs in those rocks that are the most highly metamorphosed—as the quartzo-feldspathic and syenitic rocks. These rocks, when considered with respect to their constituent minerals, do not exhibit a distinct lamination, nor when considered *en masse* do they exhibit distinct lines of stratification, as in gneiss or in mica and hornblendic schists; nevertheless, they generally pass into these latter rocks so insensibly that no line of demarcation can be drawn between them.

Third, in seams or strata, varying from the fraction of an inch to thirty feet in thickness. They alternate with strata of rock and coincide with them in strike and dip.

The ore seams, as well as the rocky strata, pitch downward beneath the surface towards the northeast at variable angles, and on this account the ore is exposed on the surface but to a very limited extent.

The seams or deposits of ore are generally remarkably pure, but they frequently contain in admixture the constituent minerals of their accompanying rocks. Apatite (phosphate of lime), hornblende, quartz, feldspar, and mica, are most common. In some portions, as in the Dickerson and Byram ores, apatites in the form of granules, uniformly disseminated through the ore seam, constitutes as much as ten per cent. of it. This percentage may be considered as the maximum, and confined to few mines, and even to very limited spaces in those mines.

Hornblende frequently enters largely into its composition, as in the Sweeds mine and many others. Mica, feldspar, and hornblende are very frequently found entering largely into the composition of the ore seam, sometimes in granules irregularly disseminated through it, as in the Hibernia mines, and sometimes in laminæ alternating with laminæ of ore, as in the Beachglenn mine. Iron pyrites (sulphuret of iron) is also a common constituent of many of the deposits, among which may be mentioned the Silver, Haggerty and Stanhope mines. Quartz in small proportion, in the form of granules, disseminated throughout the ore, is not uncommon.

Generally, when the ore contains a considerable quantity of the above-mentioned minerals in admixture, it is laminated, the planes of the lamination depending on one or more of the minerals. When, however, it is entirely or nearly free from impurities, it possesses a columnar structure, the general direction of the planes of the joints being at right angles to the inclination or dip of the ore seam.

Large wedge-shaped masses of rock, composed of quartz, hornblende, feldspar, mica, and magnetite, called by miners "horses," frequently occur imbedded in the ore seams. Generally a line of demarcation can be drawn between the "horse rock" and ore, but so insensibly do they sometimes pass into each other that it is difficult to tell where the one begins and the other ends. They vary in extent from regular seams or strata of rock alternating with the ore, to small irregular wedge-shaped masses, the longer axis corresponding with the strike of the strata, and its lamination, which is generally perceptible, corresponding with the lamination of the adjoining rocks.

Having described the geological occurrence of magnetic iron ore in this district, we are led to consider its origin, and to refer it to the particular class of metalliferous deposits to which it belongs; whether it is of aqueous or igneous origin; whether it occurs in the form of stratified or unstratified deposits.

That they cannot be referred to the unstratified deposits, appears evident from the facts stated in describing the different forms in which the ore occurs; nevertheless, it has been maintained by some that they are true veins of igneous origin, which implies that they extend to an indefinite length and breadth, that they differ in character from the rock in which they are situated, and have been formed subsequent to it. Such deposits do not usually coincide with the strike and dip of the strata in which they are enclosed, but generally cross the line of stratification and frequently send off branches of greater or lesser dimensions, at different angles from the main vein. The body of the vein is in most cases separated from the walls on either side by decomposed rock called selvage.

It will be observed that none of these phenomena can be applied to the magnetic ore deposits of this district. Nor can they be veins of segregation, which implies that the material of which they are composed has been eliminated or collected together from the surrounding rock by some chemical action. Such deposits are composed of a gangue, or materials different from the surrounding rock, and are very irregular in their form.

Stratified deposits imply that they are included within sedimentary rocks, that they are of aqueous origin, and that they coincide in geological position and in the mode of formation with the rocks in which they are situated. From the facts that have already been stated, they must be referred to this class of metalliferous deposits.

That the rocky formation of this district, including the gneiss, the hornblende and mica schists, the magnetic iron ore, and the quartzo-feldspathic rocks, are of metamorphic origin, there can be but little doubt; consequently, it is conceived that they were originally deposited by water in a horizontal position, that they are composed of materials derived from pre-existing rocks, and that they were subsequently disturbed in their position, and altered by metamorphic agencies, which have caused them to assume their present form and position. The origin, therefore, of these deposits ofmagnetic iron ore, is identical and contemporaneous with the rocky strata in which they are enclosed.

Magnetic Properties.—Whether we consider this ore-bearing district with respect to the deflection of the magnetic needle in different localities on its surface, or with respect to the magnetic polarity of the different seams of ore, or even of hand specimens, it presents a most interesting field for scientific research, which, undoubtedly, would lead to important economic applications.

To such an extent is magnetic iron ore disseminated through the rocky formation, that deflection of the magnetic needle is of frequent occurrence; so much so, that great difficulty is often experienced in surveying with this instrument. The amount of deflection and the distance at which it is produced, depend on the quantity of magnetic ore disseminated in the rock, and its position with respect to the surface; and as these are variable, no rule can be established by which the amount of deflection and the distance at which it is produced can be calculated. A very small mass of magnetic ore near the surface is frequently sufficient to reverse the needle, even when it is placed several feet above the ore, as in the case of a surveyor's compass when supported on the tripod; and on the other hand, a large body of ore a few feet beneath the surface would produce but a slight deflection.

The ore, whether in seams or small masses, generally possesses magnetic polarity and a magnetic axis. There is, however, a great difference in the amount of influence exerted on the needle in different localities; in some the action being much more powerful and at a greater distance than at others. Seams of ore five feet in thickness, have been observed to deflect the needle at a distance of thirty feet; the intensity of its influence increasing as the magnetic axis of the ore is approached. Some deposits of ore possess more than one magnetic axis. On placing the needle on the outcrop of such a deposit, so that the axis of the needle will correspond with the magnetic axis of the ore, and then gradually moving the needle in the direction of the ore seam, it will be reversed as many times as there are magnetic axes in the deposit. This is probably due to the difference in intensity of the magnetic properties of the ore in different parts of the same deposit. When a seam of ore is capped with rock

even to the extent of a few feet, its influence on the magnetic needle when placed directly over it on the surface, is very variable; in some localities producing a great deflection, and in others but very little. So variable have been the results of the observation with respect to this, that no rule can be established that would determine the greatest depth at which the needle would be affected, nor that would determine the quantity of ore from a given deflection of the needle at the surface.

The smallest fragments of ore frequently possess magnetic polarity and a magnetic axis; the extent of their magnetic qualities depending on their position with respect to the surface; the nearer to the surface, the greater will be their magnetic properties. This appears to depend on the action of surface water and atmospheric agents, for it has been frequently observed that ore, when first taken out of a mine at a considerable depth, possessed but slight magnetic properties, but on being exposed to the atmosphere for a few months or years, it would increase so much that excellent hand specimens of loadstone for experimental purposes could be selected therefrom. Seams of ore that contain numerous joints and fissures, through which water and atmospheric agents pass, possess more decided magnetic properties than those which are more compact and less free from crevices and fissures.

Whether the mountain ridges of this district possess magnetic polarity, independent of the deposits of ore therein, I am unable to say, as our observations have not been sufficient to determine.

It is maintained by some that mountain ridges and cones possess magnetic polarity, independent of the presence of magnetic iron ore, while others attribute it invariably to the presence of this mineral, even if it be in quantities so small that they cannot be detected by the naked eye.

Reich remarks, "that it is very desirable that numerous observations should be made in districts where considerable variations in the deviation are noticed, and at places not far distant, so as to ascertain whether these variations are not limited to peculiar liabilities. That this is the case, would appear from Sabine's observations of the inclination and intensity, at different parts of Scotland, which do not at all indicate disturbances effected by large mountains at considerable distances."

On the other hand, Hausteen "states that large mountain ranges exercise a sensible influence upon the mean direction of the magnetic needle. This result is obtained from an extended series of observations, made by himself, as to the deviation and dip of the magnetic needle, and the magnetic force, during a journey through Sweden, and especially through the mountainous western part of Norway." *

* Chemical and Physical Geology of Gustav Bischof, translated by Benjamin H. Paul, ii. 500.

Bishof, after citing numerous observations that have been made in various parts of the world, by different observers, in regard to the influence of mountains on the magnetic needle, concludes as follows: "Assuming that it is magnetic iron ore alone, either as masses or disseminated through rocks, to which the magnetic influences are to be ascribed, and in my opinion this is quite unquestionable, it would seem, that magnetic observations, instituted with the same degree of care as those made by Reich, would be well adapted for the discovery of hidden beds of magnetic iron ore. Such observations might, therefore, prove eminently serviceable to the iron industry. Certainly, it would be requisite first to ascertain whether mountain masses, containing only disseminated magnetic iron ore, but extending over a considerable surface, would not produce as great an effect as beds of magnetic iron ore. Sabine's observations do not appear to favor this. But, however this may be, the magnetic needle indicates the presence of magnetic iron ore, where it cannot be recognized mineralogically, and demonstrates the very general distribution of this mineral."

These remarks have a particular application to this district. That the beds or seams of magnetic iron ore produce a much greater effect on the magnetic needle than mountain masses containing only disseminated ore, there can be no doubt. Numerous observations made over this whole district have satisfactorily demonstrated this; for the greater number of the seams of ore in which the mines are situated, have been discovered by indications of the magnetic needle. These facts, therefore, have a very important economic application. The use of the magnetic needle in revealing hidden beds of ore, of sufficient extent to be of economic value, requires considerable experience, together with a knowledge of the magnetic laws, which the different varieties of ore, when considered with respect to their form and extent, possess; even then the indications of the needle are very deceptive.

In order to distinguish between a small body or mass of ore and a continuous seam or large deposit, the distance at which the needle is deflected, together with the extent of the attraction in the direction of the magnetic axis of the ore deposit, should be considered. If it be but a small body of ore, its magnetic force will be confined to a very narrow space; if a continuous seam, it will be proportionably greater.

Metallurgy of the Ores.—Of the various forms of apparatus that have been used for the reduction of iron ores in different parts of the world, the three following have been chiefly employed in this State.

1. The Catalan Forge.
2. The Charcoal Blast Furnace.
3. The Anthracite Blast Furnace.

To these may be added Renton's Furnace, which was first erected and put into operation in this State.

The Catalan Forge and Renton's Furnace are adapted to the manufacture of wrought iron directly from the ore; the Charcoal and Anthracite Blast Furnaces to the manufacture of pig iron.

Catalan Forge.—This kind of forge is said to have been used by the ancient Romans, and to have been in operation from that time to the present day. It was introduced into this State as early as the beginning of the eighteenth century, and has been in constant use ever since.

It is generally designated as the "bloomery fire." The form of its construction is very simple, and nearly uniform every where. With the exception of the hot blast, but little improvement has been made in it from its introduction into the State to the present time.

The common bloomery fire consists of a hearth of stonework, from six to ten feet square, in which there is a fireplace from twenty to thirty-six inches square, and from fifteen to thirty inches deep, lined with cast-iron plates. It is arranged with hot blast, and driven by water power.

The richest magnetic ores alone are used. When there is considerable extraneous material mixed with the ore, it is separated therefrom, either by means of washing, or by the magnetic separating machine.

The deoxidizement or reduction of the ore is accomplished by means of charcoal.

The average quantities of ore and coal required in the production of one ton of malleable iron in the form of blooms is as follows:

Ore, - - - -	2 tons.
Coal, - - - -	300 bushels.

The ore, after having been mechanically reduced by means of stamps to a condition resembling coarse sand, and if required, separated from the impurities by the magnetic machine or by washing, is introduced into the forge, in alternating charges with coal; each charge consisting of about two hundred and fifty pounds of ore and twenty-five bushels of coal.

As the process of deoxidizement and reduction progresses, the melted iron collects in the bottom of the fireplace, from whence it is removed in a semi-fluid or pasty mass, and placed upon an anvil, where it is either fashioned into a bloom, or drawn out into bar-iron, by a heavy hammer worked by water-power. When it is made into bar-iron, it requires a succession of heats and hammerings, whereby a larger quantity of materials is consumed in producing a ton of bar-iron; two and a half tons of ore, and five hundred bushels of coal, being the standard quantities allowed.

At many of the forges the iron is manufactured into anchors, which find a ready sale in New York, on account of their superior strength.

Renton's Furnace.—Various attempts have been made from time to time to invent apparatus by which wrought iron could be manufactured directly from the ore, more economically than by processes at present used. Of these, Renton's Furnace has been introduced into this State. It is situated in Newark, and was erected about five years ago, under the direction of the patentee, James Renton, for the American Iron Company, of that city.

It consists of two principal parts: first, a brick stack, sixteen feet high and thirteen feet square, enclosing a chamber, in which are placed a series of vertical fire-brick tubes, each twelve feet in length and five by eighteen inches in section; second, a puddling and welding furnace, with which the fire-brick tubes are connected.

The ore is introduced into the tubes at the top of the stack, after having been reduced to a state of great mechanical subdivision, resembling fine powder, and mixed with about twenty per cent. of charcoal dust as a deoxidizing or reducing agent.

The tubes, being filled, are left open at the top, and closed at the bottom by a contrivance which enables the furnace-man to let the charge down into the puddling furnace at his pleasure.

The heat from the puddling furnace passes around the tubes in which the ore is enclosed, and raises them to a high red heat, by which the ore is exposed to a temperature sufficient to produce deoxidizement. After the ore has been exposed to the heat for about eighteen hours, it is let down into the puddling furnace, where it is welded or collected into a ball, and from thence taken to the trip-hammer or squeezer to be fashioned into a bloom, or prepared for the rollers.

The gases formed in the reduction of the ore make their escape at the open end of the tubes.

About two tons of iron are manufactured with one furnace, in twenty-four hours when the ore is of good quality.

From the above description it will be seen that the ore undergoes two successive changes; first, it is deoxidized by means of the carbon, and thereby reduced to a metallic state; and second, it is collected together in a ball suitable to be brought under the hammer.

It is evident that only ores in the form of oxides, and those in a pure state, are adapted to this process Among the ores that that have been most successfully reduced in this furnace, is the magnetic ore of the Dickerson mine. Ores of equal purity, from other mines in this district, would unquestionably work equally as well, but I am not aware that they have been tried.

The obstacles to the success of this furnace, in an economic production of iron, appear to be :

1st. The uniform purity and minute subdivision of the ore required.

2d. The time and labor required in producing a ton of iron.

It is claimed, however, by its proprietors, that "the distinctive peculiarity and superiority of the furnace over all others is, that by its mechanical arrangement, the chemical change which is commenced and carried on in the tubes is not interrupted until the ball is ready for the hammer, thereby reducing the manufacture of wrought iron into a practical, economical, scientific and uniform system," and that the advantages of this method over the old modes, are as follows, to wit:

"The ores yield a greater percentage:

"The iron is more uniform and of a better quality:

"It is made cheaper, and does not require such a heavy outlay of capital."

As I am not in possession of facts respecting the outlay in erecting this furnace, and the cost of producing a ton of iron, I am unable to judge of its merits.

Charcoal Blast Furnace.—Formerly this kind of furnace was extensively used in the reduction of these ores; but since the introduction of anthracite coal in the manufacture of iron, and the great scarcity of charcoal, it has been almost entirely abandoned.

In 1832 there were in the State twelve in blast; and at the present time I know of only two, viz: the Oxford and Wawayanda furnace. The Oxford furnace is situated in Warren county, and is owned by Charles Scranton. The ore used in the furnace is derived from mines in the vicinity. The iron is manufactured into car wheels.

The Wawayanda furnace is situated on the Wawayanda mountain, near the New York State line. It is of large size, and arranged with hot and cold blast. At the time it was visited the cold blast alone was used, because a superior article of iron was thus produced.

The ore is obtained from the mines bearing the same name, in the vicinity.

The following materials are consumed in producing a ton of pig iron:

Charcoal, . . .	160 to 200 bushels,
Magnetic iron ore, . . .	2 tons,
Limestone, . . .	0.25 tons.

They are introduced into the furnace at the tunnel-head, in charges; each charge consisting of eleven baskets of coal (twenty-two bushels), five hundred and twenty-five pounds of ore, reduced to a state of mechanical subdivision, about the size of hickory nuts, and from 30 to 50 pounds of limestone, the quantity depending on the quality.

From fifty to sixty charges are introduced in a day of twenty-four hours, yielding from seven to eight tons of iron.

The casting is done twice a day—at noon, and at midnight.

The iron is considered peculiarly adapted to the manufacture of car wheels, and is chiefly consumed by Whitney & Son, of Philadelphia, for this purpose.

The ores of the principal mines throughout this district, in former days have been extensively reduced in these furnaces. The iron manufactured therefrom has been of excellent quality, as the various uses to which it has been applied will testify.

Anthracite Blast Furnace.—The introduction of anthracite coal in the manufacture of iron has done much for the advancement of the iron industry in this country, and must ere long place it beyond foreign competition.

The application of this coal for the reduction of rich magnetic ores, was first made by Mr. Edwin Post, who erected a furnace at Stanhope, in ——, and commenced the manufacture of iron, from the Irondale ores.

This experiment soon led to the erection of anthracite furnaces in the vicinity of the coal fields of Pennsylvania, which, to this day, have obtained a large proportion of their ores from New Jersey; the idea being entertained that the iron manufacture could be more economically prosecuted by transporting the New Jersey magnetic ores to the coal fields, and there smelting them, than by the transportation of the coal into the iron region. The prevalence of this idea has been the means of delaying the erection of anthracite furnaces in this State; but under the influence of increased and still increasing facilities for transportation, the time has arrived when the manufacture of iron may be as economically prosecuted in the iron region of this State, as in the coal districts of Pennsylvania.

The principal anthracite furnaces of this State, in which the magnetic and specular ores of this district have been worked, are four; three of which are situated at Phillipsburgh, on the Delaware river, in Warren county, and one at Boonton, Morris county.

The furnaces at Phillipsburgh are of very large size; two of them fifty-five feet high, hearth seven feet, tunnel-head ten feet, and bosh twenty and twenty-two feet. The smallest one is forty-two feet high, hearth seven feet, tunnel-head eight feet, and bosh eighteen feet.

The largest furnace, viz: fifty-five feet high and twenty-two feet bosh, works much better than those of lesser dimensions; it requires less fuel and labor in producing an equal quantity of iron.

To the present time the three furnaces have produced nine-

ty-six thousand tons of pig-iron. Their average weekly yield is five hundred tons. The maximum weekly yield of one furnace is two hundred and fifty-one and a half tons. In the smallest furnace, two hundred and thirty tons have been made per week, for six weeks in succession, with one and a half tons of coal per ton of iron.

The ores consumed in these furnaces have been obtained chiefly from the Andover mine, nearly two hundred thousand tons having already been consumed. The ores of the Roseville, Dickerson, Allen, Hibernia, Irondale and Ringwood mines, have also been used alone, as well as mixed with Andover ores.

At first, under the impression that Andover ore would not work well alone, it was mixed with hematite ore, in different proportions; but it was soon ascertained that the Andover ore worked better and made a superior iron to the mixture; and the hematite was consequently abandoned.

The coal is that variety of anthracite known as Lehigh coal, and was obtained from Mauch Chunk.

The flux is a magnesian limestone obtained from the quarry within a few hundred yards of the furnaces.

The pig iron produced at the furnaces is puddled with anthracite coal, at the rolling mill of the company at Trenton, and the blooms thus made have been manufactured into the various kinds of bar iron, railroad iron, wrought iron beams for fire-proof buildings, wire of different sizes and of the finest quality, shafts of great strength and toughness for large class steamers, and steel of superior quality.

The following materials are consumed in producing a ton of iron, in the use of the above ores, respectively:

ANDOVER MINE.

Andover ores, (Speculars,)	2.25 tons.
Coal,	1.75 "
Limestone,	0.25 "

The iron is similar to that produced from the Franklinite ore, being highly crystalline, and in its fracture having a bright metallic lustre, resembling that of antimony. A large proportion has a foliated structure, being crystallized in laminæ; another variety has a fibrous structure, the fibres radiating from the centre to the outside of the pig; and another variety has a granular structure, the grains being coarse and crystalline.

It is considered, for many purposes, superior to iron manufactured from magnetic ores, on account of its crystalline structure, caused by the presence of manganese and a more intimate union of the carbon and iron.

ROSEVILLE MINE.

Magnetic ore,	3 tons.
Coal,	2.5 "
Limestone,	0.3 "

The small proportion of limestone required is owing to the presence of carbonate of lime mixed with the ore.

The iron is red-short, but it is soft and very fine grained, and is well adapted to foundry purposes.

It has been advantageously used in the manufacture of kettles for trying out whale oil, and for this purpose, has gained considerable notoriety.

RINGWOOD MINES.

Magnetic ore, (assorted,) . . .	1.75 tons.
Coal, ...	1.75 "
Limestone, ...	0.65 "

DICKERSON MINE.

Magnetic ore, ...	2 tons.
Coal, ...	2 "
Limestone, ...	0.8 "

The iron is cold-short, even when mixed with one-fourth Andover ore, but makes a good foundry iron.

ALLEN MINE.

Magnetic ore, ...	2.25 tons.
Coal, ...	2 "
Limestone, ...	0.5 "

The iron is slightly inclined to red-short, but makes a good forge iron, and when mixed with one-fourth Andover ore, produces a superior article, equal to the Andover iron.

HIBERNIA MINES.

Magnetic ore, ...	2 tons.
Coal, ...	2 "
Limestone, ...	0.4 "

This iron is similar to that produced from the Allen ore.

In the use of the above ores, the following results have been obtained :

1. Ores containing apatite, (phosphate of lime,) produce a cold-short iron.

2. Ores containing iron pyrites, (sulphuret of iron,) produce a red-short iron, but suitable for foundry purposes.

3. Ores containing manganese produce a hard crystalline iron, which is neither cold nor red-short, but of great tenacity.

4. Ores 1 and 2, or 1 and 3, or 2 and 3, mixed in suitable proportions, produce a neutral iron, suitable for forge purposes.

The Boonton Furnace.—This furnace is forty feet high, fourteen feet bosh, five feet tunnel-head and hearth, and has six tuyeres.

Its average annual production is 6,000 tons of pig iron. In 1855 it produced 6,179 tons.

The ores used are exclusively the magnetic ores of Morris county, chiefly from the Sweeds and Mount Pleasant mines.

The flux is magnesian limestone, obtained chiefly from

Hackettstown, in Warren county, and Montville, in Morris county.

The coal is anthracite and of the Lehigh variety.

The following quantities are consumed in producing a ton of pig iron:

Magnetic ore, ...	2 tons.
Coal, ...	1.87 "
Limestone, ...	0.6 "

The Sweeds ore produces a red-short iron, and the Mount Pleasant ore a cold-short; but when mixed as they are here used, they produce a neutral iron of excellent quality, and admirably adapted to the purpose for which it is applied.

The pig iron is puddled at the works adjoining the furnace, and the blooms thus made are rolled into nail-plates and rods, which constantly employ one hundred and nine machines in manufacturing nails and spikes; of which, during the year 1855, 146,445 casks, of 100 pounds each, were produced.

Anthracite Furnace for reducing Franklinite Ore.—In connection with the metallurgy of the magnetic and specular varieties of iron ore, may be included the franklinite ore, which until Mr. Edwin Post, in ——— reduced the ore with anthracite coal, at Stanhope, and thereby demonstrated the application of that fuel to its reduction, has resisted all attempts to its introduction in the manufacture of iron.

I regret that I am not in possession of details respecting the "modus operandi," and the results of this experiment, in order to give a minute account of it, and thus render to Mr. Post the credit to which he is entitled for this valuable contribution to metallurgical science.

Since Mr. Post's experiment, two furnaces have been erected for the reduction of this ore, one at Newark, at the zinc works of the New Jersey Zinc Company, and the other at Franklin, in the vicinity of the deposit of ore. The former was erected for the purpose of reducing the residuum (chiefly franklinite) of the zinc furnaces; the latter, for reducing the ore as it occurs in its native bed at Franklin, Sussex county.

The Newark Furnace.—This furnace was erected under the superintendence of Mr. C. E. Detmold, (late President of the New Jersey Zinc Company,) during the autumn of 1855. It is a small anthracite blast furnace, twenty feet high, eight feet bosh, and four and a half feet tunnel head.

It has three tuyeres, and is arranged with hot blast. It is made of fire-brick, enclosed by a sheet-iron mantle and strengthened by wrought iron bands.

The furnace is mounted by a chimney, ten feet high and four feet six inches square, with three doors for charging the furnace. Near the top of the chimney is an opening, four feet in diameter, through which the zinc passes into a sheet-iron pipe leading to

the fan. The mouth of the chimney is closed by four dampers, which may be raised whenever the zinc and gases do not pass freely into the pipe.

The ore from which the residuum is derived, is a mixture of franklinite and red oxide of zinc. The zinc is extracted in the form of the white oxide, by a process of sublimation; the ore having been crushed and mixed with a portion of fine coal as a reducing or oxidizing agent, and then subjected to a high temperature in closely muffled furnaces, which causes the vapor of zinc to be evolved and consequently re-oxidized, in which state it is used as a paint.

The residuum obtained by this process, is composed chiefly of franklinite and carbon, in the form of a fine powder, resembling fine sand.

The fuel employed is anthracite, and the flux oyster shells.

The following quantities were consumed in producing a ton of pig iron.

Residuum,		2.90 tons.
Coal for furnace,	2.10 tons.	
" boilers,	1.10 "	
" hot blast,	0.16 "	
		3.36 "
Oyster shells,		0.43 "

For every ton of pig iron produced, one hundred and thirty-six pounds of the oxide of zinc were collected; and as the arrangement for allowing the escape of the zinc and gas was not not sufficient to carry them off, it was found necessary to keep open one or two of the dampers at the mouth of the chimney, through which a large proportion of the zinc escaped and was lost.

When the furnace was in good order, the production of pig iron was from thirty to forty tons per week; the residuum yielding from thirty-three to thirty-seven per cent. of iron, and the coal consumed *in the furnace* from one and a half to two tons per ton of iron. After the furnace had been in blast twenty-one weeks, one of the boilers failed, which rendered it necessary to "blow out" the furnace.

During the twenty-one weeks it was in blast, it consumed:

Residuum,	1,631 tons.
Coal for the furnace,	1,165 "
" " heating boilers,	607 "
" " hot blast,	88 "

Its production was:

Pig iron,	552½ tons.
Oxide of Zinc,	77,255 lbs.

The Franklin Furnace.—This furnace was erected by the New Jersey Franklinite Company, and put in blast in the winter of 1854. It was in operation only a few weeks, owing to some

imperfection in its construction and the inexperience of the workmen "in the combined operation of smelting iron and collecting zinc oxide."

It is a small blast furnace with hot blast, and arranged with a chimney at the tunnel-head, with which a pipe is connected for conveying the zinc oxide to a condensing chamber.

Although the furnace was in blast but a short time, yet sufficient data were obtained to satisfy the company that the franklinite ore can be economically smelted, yielding two products, viz: a superior article of pig iron and the oxide of zinc.

The ore used was taken from the great metalliferous deposit in Mine Hill, and consisted of a mixture of franklinite, red oxide of zinc and willemite (silicate of zinc).

The following is an account of the working of the furnace for two weeks, ending March 25, 1855. During a part of this time the zinc oxide was not collected, on account of a deficiency of power to work the fan:

Ore used,	102.50 tons.
Coal,	187 "
Limestone,	25.20 "
Iron made,	22.90 "
Oxide of zinc made,	22,084 lbs.

The iron produced from the franklinite ore is of a very peculiar quality and excellency. It is particularly adapted to the manufacture of steel and malleable iron, and hence commands a higher price than pig iron manufactured from other ores of iron. Dr. A. A. Hayes, of Boston, has analyzed a specimen of iron produced at the Franklin furnace. The following extract is taken from his report thereon to the company:

"In general physical characters, the sample resembled 'white pig iron,' but a closer inspection shows a different molecular arrangement, by which the crystals are affected in form and distinctness by chemical dissection. The mass of iron exhibits *two* distinct crystalline aggregations; the broad folia of one of these being separated by thin laminæ of a different color, hardness and composition, in this respect resembling meteoric iron. The color of the specimens is nearly that of the finer samples of metallic antimony; the masses divide easily, but the angles and edges of the imperfect crystals are harder than the hardest cast-steel, and in the attempts to obtain a powder, they became imbedded in its surface; a mean specific gravity is at 60 F. 7.665. Electrically, it presents a positive part, closely invested by a relatively highly negative body. Chemically, its characters are of an imperfect steel; its carbon constituent is in the state of that which has been deposited from carburetted gases by a high temperature, and has no properties in common with graphite.

No trace of sulphur was found. A trace of phosphuret of calcium could be detected, but neither zinc, chromium, vanadium,

or copper could be found. Associated with the carbon is an accidentally earthy matter, derived doubtless from the slag, and in this a minute quantity of unreduced franklinite. This occurrance of ore in iron I have often noticed in samples which *do not* present graphite. There was no evidence of the existence of the metallic bases of the earths either.

Analysis.—In the following statement the iron is presented as a simple alloy, consisting of one hundred parts of

Pure iron,		93.364
" manganese,		3.204
" carbon,		2.250
Slag, silica,	6.40	
Ore and alumina,	2.40	
Lime,	1.70	
		1.050
		99.868

"The mechanical and chemical constitution of this iron points to great ease in working it into malleable iron. Both the manganese and carbon are readily oxidized by the puddling, while the pure iron will take the form of tough or malleable iron very readily. It is also the kind of metal required for manufacturing steel, by fusion of oxide of manganese, losing in the operation a portion of carbon and all its metallic manganese."

An essay of a bar of franklinite iron, manufactured at Stanhope, by Mr. Edwin Post, was made at the French National Establishment, for the manufacture of chains and anchors for the navy, by M. Theophile Bornet, chief of the works, and author of the "Tables of the strength of Metals."

"REPUBLIQUE FRANÇAISE."—ADMINISTRATION DE LA MARINE.

Forges Nationales de la Chassande.—Assay of a bar of Iron, from a new ore, THE FRANKLINITE, *from New Jersey, United States.*

The bar, obtained by direct treatment of the ore in a catalan forge, is 25 millimetres by 24.5 millimetres square, and presents a section in square millimetres of	612.50 *m.*
Charge under which the bar began to stretch,	15,000 *k.*
Elastic force, per millimetre,	24.5 *k.*
Charge under which the bar broke,	25,000 *k.*
Absolute tenacity, per millimetre,	40.8 *k.*
Elongation of the bar at the moment of fracture, per millimetre,	5 *m.*

Aspect of the fracture—all nerve. The bar was imperfectly welded, and contained fissures which diminished the real surface exposed to traction; in consequence, the *absolute tenacity*, had the bar been sound, would have been greater. At the moment of rupture, but litte heat was disengaged.

Observations.—The tensions of the hydraulic press of the national forges, are given by means of an excellent apparatus, which indicates the results with the greatest precision. An immense number of experiments have been made with this press, not only upon all the irons of France, but upon the best irons

of England, Sweden, Spain and Siberia; never, until the present assay, has any bar been tried, the *absolute tenacity* of which surpassed 40 kilogrammes per millimetre.

(Signed,) TH. BORNET,
Chef des Travaux aux Forges Nationales de la Chassande.

GUERIGNE, 12*th July*, 1850.

P. S.—The franklinite iron tried at the forges, works and welds to perfection.

(Signed,) T. BORNET."

(To be continued.)

ART. IV.—CHIRIQUI IMPROVEMENT COMPANY — REPORT By C. S. RICHARDSON, MINING ENGINEER.

[Continued from page 260, Vol. VII.]

Gentlemen:—In reply to the question submitted by some of the members of your honorable Board—What is likely to be the opinion of practical English engineers on the merits of your undertaking?—as one of that body I respectfully beg to say: That if the facts are borne out as given in the Reports, Maps, and other documents laid before me, they must be unanimous in its favor. The specimens of coal sent for examination are very positive in their nature, they admit of very little doubt as to the quality and productiveness of the seams from whence they were taken; if you could furnish me with a descriptive vertical section of the strata, and approximate the position of the "faults," slides, dikes, troubles, &c., peculiar to this formation, so that I might arrive at some definite conclusion as to the cause and probable effect on the measures by these disturbing phenomena, I should be able to decide with greater certainty on their relative value; but in the absence of such information I will proceed to give you my views as deduced from the Report of Professor Manross, your Geologist.

The system, no doubt, is the early tertiary, from its fossil index; at all events the upper part of it is. The course of the measures, as delineated on the map before me, is in a north-west direction. Twelve seams of coal are represented in them, commencing at the eastern end of the lagoon, and terminating in the Sierschick Creek on the Changuinola river in the west, a distance of about fifty miles. These seams mostly dip at an angle of 20 degrees to the north-east or under the sea. See Fig. 1. On the west they are 10 or 12 miles wide before they reach the sea, in other parts not more than 2 to 5 miles wide. I shall denom-

inate them as three groups of coal seams, and class them as the Upper, Middle, and Lower series; the superficial area cannot be defined, as the line of junction of the primitive with the secondary formation is not delineated on the map. This is much to be regretted, inasmuch as it would identify the local position of the lower seams, and thereby in all probability enlarge the present supposed dimensions of this magnificent coal field. But, take it as it is, you will find quite sufficient coal to meet the requirements of five millions inhabitants for the next 400 years, for as near as I can estimate there must be at least 300 square miles or 192,000 acres of surface underlaid by coal, and each acre, at the very lowest computation, will produce 10,000 tons.

Prof. Manross says there is great uniformity in the character of the rocks that line the coast, consisting of sand and limestones, but their dip or inclination is not regular. Now this must naturally be expected, being in the vicinity of volcanic mountains, although upheavals are not always an index of those plutonic phenomena; he considers the variety of inclination to be the result of intruding ridges of trap. I presume he means trap or elvan dikes, unless they are trap rangers, like those at Paterson, New Jersey, and Mount Holyoke in Massachusetts, which repose *on the* sandstone formation; if like these, they will in no way materially break the continuity of the seams, but if caused by protruding dikes they will produce "faults."

In setting out your colliery operations care must be taken to ascertain the locality, dip, and bearing of these dikes; this once known, a great deal of difficulty to the miner may be avoided; the works may be prosecuted with more certainty, progress with greater speed, and arrive at a successful issue at less than one half the usual cost. I have examined three specimens of coal; two of them are what we term semi-bituminous, and known in South Wales as Cardiff steam coal; one specimen is of a ligneous nature; its relative position, in situ, may be readily identified, it may justly be called a wood coal; its fossiliferous properties are very distinct, it is the newest or upper one of the series; I think this is from "Secretary" top seam. No. 2 specimen taken from Popes Island and Saddle Hill, is strongly bituminized; it belongs to the middle group; I think it will coke when mined from a depth of 20 or 30 fathoms. This specimen as an outcrop coal is most excellent: I never should desire a better: it gives all the indications of belonging to or coming from a rich seam. Outcrop coals, on account of their long exposure to water and atmospheric action, lose by evaporation a great portion of their most valuable properties, hence very little reliance is to be placed on their value by analysis. It is a very common error in persons having the idea that the real value of a coal field can be determined by samples of the outcrop; in the present instance the specific gravity given is only 1.270. I presume this is calculated

from some of the poorest specimens, for among some that I have tried there is one as high as 1.375. The average of the analyses given in your reports is as follows:

Volatile parts, - - - -	35.705
Carbon " - - - -	57.955
Waste and ash, - - - -	6.340
	100.000

In publishing the results of this assay, you do not give justice to even the outcrop coal you have in your possession. I know of a surface seam in the Taff valley, South Wales, similar to this; it is a little below New Bridge; it is again cut at Pont-y-prid 30 fathoms deep, where it produces some of the finest upper seam, steam coal that is now sent into the port of Cardiff. It may perhaps be considered premature, and I may err in my predictions: but I do say—and say it too, without *any fear* of contradiction—that the produce of the seams of the middle series will give an equivalent to 75 per cent. of carbon. No. 3, or lower group—are opened on in the Sierschick and Jinia creeks, on the Changuinola river; about 10 or 12 miles inland from the coast, there are 4 distinct seams, the upper one of which is cut in Cultivation creek on the south shores of Shepherds' harbor. These are the richest specimens, and fully decide the character of the coal that will be found in the lower seams of these measures, and I have no hesitation in saying they will very nearly, if not quite, equal the Welsh steam coal. I have not time to spare just now to make an analysis of all the samples, but at some convenient period I will do so; for I think a perfect knowledge of the real properties of these coal seams very interesting, not only as in application to, or for your own particular advantage—but on public grounds, for they must eventually become of immense value to the steam marine of all the Eastern and Western nations: their geographical position is all that is desirable. They are in fact, to use a trite phrase—"the right coals in the right place." The quantity of merchantable coal that may be produced from these three series of seams can be computed with sufficient accuracy from the data given by Prof. Manross, the result of which is as follows:—

"SECRETARY"—upper group—3 seams opened on—respectively 4 feet, 6 feet and 2½ feet thick—12½ feet soft, open coal, say 75 lb. to the cubic foot, making $3\frac{1500}{1000}$ tons aggregate per superficial yard of seam: allow 25 per cent. for waste in working, and it gives a net produce of 13,672 tons to the acre; it is reasonable, however, to suppose these seams will become more contracted in depth on account of compression, but then the coal will have an increased density, which will equalize the difference between weight and bulk.

POPES ISLAND and SADDLE HILL—middle group—6 dis-

tinct seams, from 2 to 5 feet thick—average 20 ft. aggregate—specific gravity said to be 1.27=79.37 lb.—say, fractions omitted 80 lb. per cubic foot; now as some of these seams appear to be "Thin Coal," one-third must be allowed for waste in working, which at 80 lb. gives $6\frac{4}{10}\frac{8}{0}\frac{3}{0}$ tons to the superficial yard of seam, less $\frac{1}{3}$ equals 20,740 tons to the acre.

CHANGUINOLA—lower group—from the description given, there appears to be a greater depression in the strata here than at any other point; the angle of dip being over 30 degrees. These seams are thinned out at the edges; by this, it would appear to be the selvage of the measures. I think it very probable, as the upheaval of the primitive base, which without doubt is constant in its action, although imperceptible to our visual senses, would first fracture the edges of the coal formation and tilt up its strata. There have been 9 seams found here, ranging from 1 to 3 feet in thickness. I will, however, reduce them, to approximate their value, to three; and set their aggregate thickness at 10 feet. This is the finest coal yet seen, particularly the specimens from Cultivation creek on the shores of Shepherd's harbor, which is one of this group; it is very compact and will weigh 82 lb. to the foot: in its broken or merchantable form 54 lb. to the foot—bulk in stowage 38 feet cube to the ton; allowing again one-third for waste in working and pillar, the net product will be 10,630 tons of salable coal to the acre.

How near the Saddle Hill group will approach the above, can only be ascertained by an instrumental survey, but I entertain an opinion that many more seams intervene between the lower and middle series. There will also be found in "Robalo" river the same seams as are opened on at Sierschick, unless this part of the formation has been entirely denuded by the action of the sea. Now if we may judge by analogy, there ought to be under the middle group one or two seams of a much greater thickness than any yet seen; and I would advise you to direct your engineers' attention to this important feature, as it will materially improve the value of the entire property.

MINING OPERATIONS.

I shall not be able to give you a very good outline of the cost of this part of the works, as the description you have sent me of the formation is so curtailed and vague, as scarcely to allow me scope enough to form an opinion; but to illustrate the matter, I will adopt an imaginary case.

At "Secretary" the cliff is said to be about 40 feet high above the beach; midway up, or 20 feet from its base, a seam of coal is seen outcropping, there is another on the beach a little way below the cliff, and another some few feet under water; let us suppose the distance between the upper and lower seams is 40

feet; a cross section of the strata through the cliff would present the seams as shown in the following sketch.

At the first commencement of your mining operations there must be some exploring drift run in, to prove the dip and range of the seams—one of those, if properly located, may form the future adit, or main drift of a considerable work: it must be kept up high enough above high water mark to avoid the heavy swell of the ground sea, during the prevalence of the "Northers." The seams dip at an angle of 20 degrees; you will perceive this level intersects the upper seam at 95 feet from its entrance, all the others lie below. You may commence taking away coal from this point, if you like; it may do very well for domestic use, and may be mined at a profit perhaps. But if you take my advice, you will not offer any of it for sale, for the generation of steam on board the Atlantic steamers; if you do, a risk is incurred of having a bad name given to your coal at the onset. I can furnish you, if desirable, some lamentable instances of errors of this kind. This main exploring drift becomes the future level course; the main intake and wagon road; it should be 12 feet wide, and driven across the strata for 150 yards; in its course it will intersect in all probability other seams, but whether it does or does not, this will be far enough for the commencement of a small colliery. You now commence at the surface, and sink a shaft of sufficient size to become the future upcast shaft of the entire mine, say 16 × 9 within the timbers; this is divided by bratticing into two equal parts, half of which is for the pump and uptake, or ventilating shaft, and the other for the winding-shaft. A large plat or lobby is cut at the end of main drift, wherein is built a ventilating furnace, and securely walled off air tight from the intake; or if a Shaft-fan, Steam-jet, Radiating grate, Disk pump, or other modern contrivances are introduced, the furnace may be dispensed with altogether. But whatever mode of ventilating the mine is to be adopted, a strong steady currrent of air at the rate of 5 feet per second, or 20,000 cubic feet per minute, must be kept up, and constantly coursing itself through all the workings. I must here remind you that this is a very important matter, and one on which the success and profit of your future mining operations will greatly depend. Your workings, you may perceive, are all on the rise, gases will accumulate here in the goaf unless the current is pretty strong; you have at the very onset to make provisions for working a fiery seam—the coal is of a nature to promise this any how. The only way to avoid accidents, is to be prepared for them; the saving of five dollars in the shafts and drifts at the beginning, will cost the company $95 when the first man gets killed by fire damp. Look for instance at the dreadful explosion a few months ago at "Aberdare Colliery," South Wales. Now take a piece of their upper seam coal, and your middle group coal, put these two

together, I should like to see the man who could distinguish the difference. If Aberdare coal produces the explosive gas, "called carburetted hydrogen," why should not yours? I say it now—before you have sunk a fathom on any of the seams, that at 40 fathoms deep you will have fire damp to contend with, but this does not depreciate the value of your mines. All good coal gives off gas. You have only to lay out your works in a proper manner at the onset to meet these contingencies; to the practical engineer they are very plain and simple, to the uninitiated very complex. There are many hundreds of colliery owners, who have had to pay dearly for winning coal without having paid due regard to ventilation; and to all new beginners in this most valuable branch of mining enterprise I would say: consider well the old adage, from the "faults of others learn to correct your own failings." When the winnings are first made by the shaft intersecting the seams, a headway course is driven out right and left at a gently ascending grade; bords or stalls may then be commenced as fast as the headways progress. Coal is now ready for hauling; it is sent up by a skip, or by the wagon and cradle, the latter in all cases preferable; landing on the lobby it is run out by the main drift on the pier or platforms on the beach, screened and put on shipboard. The shaft, from the adit upwards, is only used for ventilation, and hauling such coal as may be required for the use of the steam engine. The quantity of coal that may be returned, will depend on the extent of the workings; within twelve months after the first seam is won, from 80 to 120 tons per day may very easily be raised. This, I consider will be quite extensive enough for a commencement. Other collieries may be opened out as fast as the trade increases or the requirements of the company want them to be brought into play. To open this mine, and put it into a good state of working for permanency and safety, will amount to about the following cost:—

160 yards Main Drift,		$15 00	$2,400
300 " Headway Drift, 1st Seam,			
300 " " " 2d "	}	3 00	3,600
300 " " " 3d "			
800 " Stallway Course,		2 50	2,000
Lobby,		2 50	200
10 fathoms Shaft down to adit,		1 20	1,200
34 " " to 3d Seam,		1 50	5,100
1600 yards Stall tramway,		1 50	2,400
150 " Main Drift or adit, do		2 50	375
34 fathoms pit work complete,		75 00	2,550
20 Horse Power Steam Engine,			4,500
Wagons, Mules and Harness,			1,000
Pit-head, Drums, Ropes, Cradles,			1,000
Engine House, Ventilating Furnace,			1,000
Buildings, Cottages, Screens, &c.,			6,500
The Pier or Jetty, timber framed,			700
Freight of materials,			1,500
Engineering, Contingencies, and Miscellaneous Expenses,			3,975
			$38,000

SUBTRACTION OF DECIMALS.

Rule.—Arrange and cut off the decimals as in addition.

EXAMPLE.

	fath.	ft.	in.
From	4	2	9·7824
Take	3	4	8·91773
	1	4	0·86467

MULTIPLICATION OF DECIMALS.

Rule.—Multiply as in whole numbers, and cut off as many figures from the product as there are decimals in the multiplier and multiplicand.

EXAMPLE.

	fath.	ft.	in.	
Multiply	2	4	7·92486 by 24	
			6	
	16	3	11·54916	
			4	6 × 4 = 24
	66	3	10·19664	

	fath.	ft.	in.	
Multiply	9	3	1·4872 by 37	
			6	
	57	0	8·9232	Here we multiply by 6 twice because 6 times 6 are 36, and add the given number which makes it equal to 37, or 6 × 6 + 1 = 37
			6	
	342	4	5·5392	
	9	3	1·4872	
	352	1	7·0264	

	ft.	in.
Multiply	14	9·746 by 12
		12
	177	8·952

DIVISION OF DECIMALS.

Rule.—Divide as in whole numbers, and cut off as many figures in the quotient as the decimal places in the dividend exceed those of the divisor.

EXAMPLE.

	fath.	ft.	in.
Divide	2	4	3·7 by 6
6)	2	4	3·7
	0	2	8·61

fath.	ft.	in.
7) 4	2	10·80994
0	3	10·04427

fath.	ft.	in.
8) 15	5	0·3316
1	5	10·5414

ALIQUOT PARTS OF A FATHOM.

TABLE.

Parts.		Feet.	Inches.
½	of a fathom is	3	0
⅓	ditto	2	0
¼	ditto	1	6
1-6	ditto	1	0
1-8	ditto	0	9
1-9	ditto	0	8
1-12	ditto	0	6
1-16	ditto	0	4½
1-18	ditto	0	4
1-24	ditto	0	3

REMARKS.

It has been observed that the radius in every case is 6 feet or 1 fathom, consequently the number of fathoms in the given side, whether that side be hypothenuse, perpendicular, or base, will be the multiplier of the tabular numbers, and should there be a fraction in the multiplier, the multiplicand must be divided by that fraction agreeably with the rule of practice. The table of aliquot parts of a fathom, in the adjoining page, will be found useful in facilitating this part of the process.

In some of the following examples the product has been obtained in fathoms and parts; but we would recommend the learner to carry on the work in *feet* (except in cases where the answer is required in fathoms), as he will find it more simple and expeditious; we speak of the *multiplicand* or number *multiplied;* the *multiplier* must invariably be fathoms, and should the given side be nominated in feet, it must be divided by 6, to bring it into fathoms, before the operation is begun by the foregoing cases.

It may be further noticed that when any of the given sides in the tables amount to 6 feet, they are expressed in fathoms, &c. but whenever it may be required to produce the answer in feet, &c. the numbers should be reduced to that measure before they are multiplied, and this can be done by mere inspection; viz.

		fath.	ft.	in.			ft.	in.
Table 2d, 52°	Base	1	1	8·1560	state	Base	7	8·1560
	Hyp.	1	3	9·6053		Hyp.	9	9·6053

PRELIMINARY CHAPTER TO THE PRACTICAL DIALLING EXAMPLES.

It must have been matter of regret to every reflecting, well-informed, and interested persons, that (previous to the present work) nothing has ever been published with a design to assist the British miner in his subterraneous operations; and while the press has teemed with publications, distinctly and exclusively adapted to benefit the navigator, the architect, the sculptor, the surveyor, and even the mechanic and artisan, not a single effort

has ever been made to extricate the miner from the disadvantages under which he has ever labored, (solely from the want of a plain, concise, technical, and scientific treatise on dialling, accompanied with appropriate tables,) although his profession yields to none in importance and utility; in fact, it may be said, in a certain sense, to be the parent of every art and science in the world; the use of metallic substances, in some shape or other, being indispensable in every one of them: nevertheless this highly essential art has hitherto been totally disregarded by all classes of mathematicians, and while the famous invention of logarithms has caused the science of trigonometry to soar to the very skies, and traverse old ocean's vast and unfathomable expanse, the unsupported miner has been left to struggle under the greatest disadvantages, with nearly as little obligation to geometrical science, as his antediluvian progenitors; and although he has done every thing that deep thought, strong natural understanding, unwearied perseverance, and inventive genius (unassisted by trigonometrical demonstration) could possibly accomplish, yet, for the want of mathematical light, his exertions have been ineffectual and insufficient to disentangle him from the difficulties with which he has been encircled; hence his avocation has, in general, been replete with toil, anxiety, apprehension, dissatisfaction, and disappointment.

How far the present work is adapted to answer the great end in contemplation, must be left for the judgment of the mining world to decide; and we doubt not but the defects (real or imaginary) which may be considered to exist in the application, will be passed over and excused by every liberal man, on the grounds already stated in the preface; having an unshaken confidence that the fundamentals of the work, comprised in the trigonometrical tables, will be found plain, true, and unexceptionable.

Definition of Right-angled Triangles.—In order to use the following tables with due effect, there is no necessity that the reader should understand any thing of the science of trigonometry, that part of the work having been accomplished already to his hand; so that, by the help of a few of the common rules of arithmetic, he may obtain, with the greatest ease and certainty, every thing required to be known in the geometrical part of mining.

Previous to elucidation of the simple method of working by tables, it may be satisfactory to introduce the operation by a few preliminary observations and extracts on the nature and properties of right-angled triangles.

Plane trigonometry is the art of measuring the sides and angles of triangles described on a plane surface, or of such triangles as are composed of straight lines.

The theory of triangles is the very foundation of all geometrical knowledge, for all straight-lined figures may be reduced to

triangles. The angles of a triangle determine only its relative species, and are measured in degrees, minutes, and seconds; but the sides determine its absolute magnitude, and may be expressed in fathoms, yards, feet, or any other lineal measure.

Theorems.—A right-angled triangle (the only kind generally necessary to be treated of for mining purposes) is that which has one right angle in it; the longest side, or that opposite to the right angle, is called the hypothenuse, the other two are called the legs or sides, or the base and perpendicular: or, by Euclid's definition, "In a right-angled triangle, the side opposite to the right angle is called the *hypothenuse*, and of the other sides, that upon which the figure is supposed to stand is called the *base*, and the remaining side the *perpendicular*."

The three angles of every triangle are together equal to two right angles, or 180 degrees.

The greater side of every triangle has the greater angle opposite to it.

The squares of two sides of a triangle are together double of the square of half the base, and of the square of a straight line drawn from the vertex to bisect the base.

The sum of the three angles of every plane triangle being equal to half a circle, or 180 degrees, it therefore follows that if either acute angle, in such triangle, be taken from 90°, the remainder will be the other acute angle, or the complement.

The supplement of any angle is what that angle wants of 180°; hence the supplement of any one angle is always equal to the sum of the other two.

A few other properties of right-angled triangles may be worthy of notice, viz.: when the angle opposite the base is 30°, the hypothenuse is exactly double the length of the base.

When the angles are 45°, the base and perpendicular are equal.

When the angle opposite the base is 60°, the hypothenuse is double the length of the perpendicular.

Application.—To show how a knowledge of the foregoing theorems may be rendered useful in mining practices, suppose in the triangle A B C, on page 24, the base B A represented a drift or cross-cut, and the side A C a lode, making an angle with the base of 66° 30′; consequently the angle A must be 23° 30′, because it requires that number of degrees to constitute a right angle, the complement of the angle A, or 180°, the supplement of the triangle A B C.

Again, suppose the angle C of the diagonal shaft C A, page 25, was found to be 39° 30′, then the opposite angle A must contain 50° 30°.

We now approach towards the actual use of the tables, and have succeeded, we hope, in clearing all impediments out of the learner's way, so that he will find no difficulty in readily applying the numbers to dialling operations. We have previously set a few examples of the mere act of taking out the primes, and have

studiously endeavored to render every thing so perspicuous and comprehensible as the nature of the work would possibly admit. But should any one have gone thus far and still find an obscurity hang over him, so that he cannot penetrate into the nature of the subject as he would wish, or as he may have expected, yet let him not be discouraged; this will always be the case with every one who calculates on fully comprehending any thing connected with the mathematics by definition or description only. Let him steadily, attentively, and perseveringly proceed with the examples, and if he is properly interested in the matter, he will soon find the subject open with perspicuity and demonstration on his mind, and convey to him the incontrovertible assurance of the truth of the calculations, as well as the correctness of his own views, ideas, or conceptions of the subject.

TABLE I.—EXAMPLE.

When the angle is 9° and the hypothenuse 1 fathom, what is the length of the other two sides of the triangle respectively?

	in.		ft. in.
Answer, Base	11·26393	Perp. 5	11·11356

EXAMPLE.

When the angle is 48° 15′, or 48¼ degrees*, and the hypothenuse 1 fathom, what are the lengths of the other sides?

	ft. in.		ft. in.
Answer, Base 4	5·71613	Perp. 3	11·94348

TABLE II.—EXAMPLE.

When the angle is 35° 45′ or 35¾ degrees, and the perpendicular 1 fathom, what is the length of the hypothenuse and base respectively?

	ft. in.		fath. ft. in.
Answer, Base 4	3·8326	Hyp. 1	1 4·7163

EXAMPLE.

Given the angle 59° 30′, perpendicular 1 fathom, the other sides are required.

	fath. ft. in.		fath. ft in.
Answer, Base	1 4 2·2317	Hyp. 1	5 9·8612

TABLE III.—EXAMPLE.

Given the angle 5°, base 1 fathom, the hypothenuse and perpendicular are required.

	fath. ft. in.		fath. ft. in,
Answer, Hyp.	11 2 10·10734	Perp. 11	2 6·96374

* In this example, as the angle exceeds 45°, it will be found standing on the right hand side of the page (as already explained), and the denomination of the required sides will be found at the bottom. A little attention to this order will prevent the mistake, which may otherwise take place, by an inversion of the base and perpendicular.

EXAMPLE.

Given the angle 30°, base 1 fathom, the other sides are required.

	fath.	ft	in.		fath.	ft.	in.
Answer, Hyp.	2	0	0	Perp.	1	4	4·70766

NOTE.—The foregoing examples serve only to exemplify the manner of taking out the primes from the tables, and as the given side is exactly one fathom, of course the tables give a direct answer. In the following examples the mode of taking out the tabular numbers is precisely as the foregoing, but the number of fathoms contained in the length of the given side, will be the multiplier of the other sides of the triangle.

(To be continued.)

ART. V.—ORGANIZATION OF THE SCHOOL OF MINES AT FREIBERG, SAXONY.

ALL the branches of mining, and the sciences which relate to it, are taught at the Academy at Freiberg; the students are furnished with opportunities for performing mining work, and are thoroughly instructed in practical mining and metallurgy. Admittance to the mines and foundries is not only permitted, but it is rendered very easy, for these latter establishments are mostly in the suburbs of the city, whilst within a few leagues of Freiberg are important collieries, metalliferous mines, and quarries—collections of minerals, models, &c., laboratories of chemistry, and natural philosophy, and a large library, are the complementary means of study.

The courses which commence in each year on St. Michael's and terminate at the end of July in the following year, are at the expense of the government or of the students.

The students who pursue their studies at the expense of the State are divided into *regular students* and *outsiders*.

The *regular students* apply themselves to the art of mining and smelting, and pursue all the courses. They cannot obtain admission until they have passed a theoretical examination, and pursued a practical preparation. If they give evidence of particular merit and are poor, they can obtain the advantage of gratuitous instruction and some academical subsidy, and other advantages—such as compensation for services in the mines and foundries. They pursue their studies according to established regulations, and assist at recitations, pass an annual examination, and at the completion of their studies a general one. In order to obtain employment in the service of the mines, it is necessary that they should previously pursue a course of practical labor; at

least, they should not apply themselves to purely scientific pursuits.

The Saxons only are admitted as (*internes*) proper members.

Applicants should be from sixteen to twenty-three years of age, and upwards, of good health, and free from all bodily defects.

The applications for admission should be made to the High Tribunal of Miners, not later than the month of February in the year during which ad nission is desired. The applications should be accompanied with a certificate of baptism, one of good health, from a physician; of vaccination, and of good moral character. Also a certificate of capacity to pursue the academical studies, and in case of miners, a certificate of capacity from parents or teachers.

The applicants must pass a satisfactory examination relative to their previous studies and the application necessary for the Academical sciences. The attainments required are—correct and legible Penmanship, the German language, the elements of Algebra, and Geometry, Stereometry and Rectilinear Trigonometry; the Latin language, so as to translate correctly Cæsar, or the easier works of Cicero; Geography and Universal History, mechanical and pencil Drawing.

They are likewise examined in the French and English languages, a knowledge of which is quite a commendation.

Those who have passed a satisfactory examination, but who have not spent a year in the mines, should enter upon a particular course, in order for practical preparation, such as is prescribed to miners' apprentices.

The examination takes place in the second week of the pass-over, and from that time to the commencement of the course at St. Michaels, there is an opportunity to obtain the practical preparation required.

There are foreign students who devote themselves to some other pursuit than mining; such as Mechanics, Geometry, Architecture, &c.—who attend only a certain course. They should produce a certificate that they are prepared for the course upon which they desire to enter, and on presenting these, they undergo an examination, previously to the commencement of the course. This examination relates to the German language, mathematics and drawing.

They then enjoy the same facilities as the regular students.

The outside students who desire the advantage of a course which requires other preliminary attainments, should undergo a corresponding special examination.

During the period of study, the outside students are subject to the same discipline, as regards their conduct and application, as the regular students. They are likewise restricted to the same order of exercises and examinations upon the studies they pursue.

The application for reception should not be presented to the supreme tribunal later than July in the year in which they desire to be admitted.

Every student, outside or inside, upon his admission and matriculation, should pay, in addition to the three thalers for enrolment, 20 thalers to the treasurer of the school (74 francs) yearly, and 4f. 95 towards lights and fires in the Lecture-rooms. Young students in destitute circumstances are not permitted to receive assistance from the funds unless they possess remarkable talents. The certificates granted at the close of the course, show whether the students have belonged to the class of regular students, or attached students, and in case of the latter, they show to what branch of industry these have been destined.

Strangers who desire to pursue their studies at the Freiberg School, at their own expense, should be sixteen years of age.

Students who defray their own expenses are allowed to partake in the practical preparations, according to the custom of mining students, as well as the reviews and the practical demonstrations; and at the end of the course they undergo a general examination.

In order that the Academical course may be profitable, a knowledge of the classics is required of students, to the same extent as required of German gymnasiums. If any lack of this instruction can be tolerated, there is, however, always required an education sufficiently extensive to comprehend perfectly the lessons in the sciences. A knowledge of living languages, especially French and English, is very useful.

With regard to mathematics, it is necessary to have advanced as far as Rectilinear Trigonometry, inclusive. The first elements of drawing are likewise desirable.

(To be continued.)

JOURNAL OF MINING LAWS AND REGULATIONS.

MARINE TAX ON CANAL BOATS.

Matthew Buckley vs. *Charles Brown, Col.*

Interesting case and opinion concerning the right to tax canal boats and boatmen running on the Schuylkill canal, and trading between Philadelphia and New York, with Custom House and Marine Fees.

This cause, with several others, had, by certiorari, been removed from the Court of Common Pleas of Philadelphia county.

The plaintiff was the captain of a canal boat, which had been duly registered, enrolled and licensed at the port of Philadelphia, and on the 27th of March, 1855, applied to Charles Brown, the defendant, as collector of the

port of Philadelphia, for the renewal of the license of said boat, as required by law.

The defendant refused to grant a renewal unless the master of the boat would pay the sum of $1 therefor, and the sum of $4 89 as "Marine Hospital Tax."

The payment of the Marine Hospital Tax was demanded by virtue of the act of Congress of 16th July, 1792, section 2. This act provides "that no collector shall grant to any ship or vessel whose enrolment or license for carrying on the coasting trade has expired, a new enrolment or license, before the master of such ship or vessel shall first render a true account to the collector of the number of seamen, and the time they have severally been employed on board such ship or vessel, during the continuance of the license which has so expired, and pay to such collector 25 cents for every month such seamen have been severally employed as aforesaid." The sum thus paid is retained from the wages of the seamen, and is to form an hospital fund for the support and maintenance of disabled seamen.

Under the act, it has been the practice, prior to 1846, to tax, indiscriminately, all hands and mariners engaged on boats and vessels trading on our rivers. This tax became a great burden to canal boats and vessels engaged in the inland navigation of Pennsylvania and other States; and to relieve them from this burden, Congress, on the 20th July, 1846, enacted the following law:

Act of Congress of July 20th, 1846.—Sec. 1. "That the owner or owners, master or captain, or other persons employed in navigating canal boats without masts or steam power, now required by law to be registered, licensed, or enrolled and licensed, shall not be required to pay any Marine Hospital tax or money; nor shall the persons employed to navigate such boats receive any benefit or advantage from the Marine Hospital fund; nor shall such owner or owners, captain or other persons, be required to pay fees, or make any compensation for such register, license or enrolment and license; nor shall any such boat be subject to be libelled in any of the United States Courts for the wages of any person or persons who may be employed on board thereof or in navigating the same.

Sec. 2. "That all acts and parts of acts repugnant to the provisions of this act be, and the same are hereby repealed."

In practising upon this act of Congress, the Secretary of the Treasury issued to the Collectors of the different ports of the United States, instructions to the effect—

First. That under the act of 20th July, 1846, vessels or boats which ply altogether on tide and other navigable waters, cannot be deemed canal boats entitled to the privileges of that act.

Second. That the exemption under the act of 1846 of canal boats from the payment of fees and hospital money, cannot extend to boats or barges, exceeding 50 tons, although without masts or steam power within themselves, when the usual practice of such boats or barges, is to come out of the canals, and trade by aid of steamboats and propellers, on natural navigable waters from district to district. Such boats or barges thus becoming liable to the regular payment of hospital money or fees, besides being by law required to be registered, licensed, or enrolled and licensed, and governed by the several provisions of the law regulating the coasting trade.

Under these instructions from the Secretary of the Treasury, the collector of the port charged Hospital dues to the boat of the plaintiff, in conformity with the act of 1798, and notwithstanding the act of 1846. The plaintiff paid these dues under protest, and this action was brought to recover them back, with interest.

The case was submitted to the Court upon a statement of facts which were undisputed.

The boat in question is of 123 tons burthen, and is without masts or steam power. At the time of the application for the renewal of license, said boat was, and has uniformly been before and since engaged in the coal trade, be-

tween Port Carbon, in Schuylkill county, Pa., and the City of New York, by way of the Schuylkill Navigation and the Delaware and Raritan Canal. The whole distance from Port Carbon to New York, by the said route, is 228 miles, of which 151 are by land, (108 on Schuylkill Navigation, and 43 on the Delaware and Raritan Canal,) and 77 upon tide water.

The case was fully argued by B. Tilghman, Esq., for plaintiff, and by James C. Vandyke, Esq., Attorney for U. S. for defendant.

Opinions of Court, by Justice Grier.—It is a great grievance that the revenue laws passed by Congress have become so numerous and complicated, that it is often difficult to ascertain what is the existing law on any particular subject. In the construction of other laws, when one statute supplies or changes the provisions of another, the latest is construed as a repeal of the former. But on the construction of this mass of contradictory revenue laws, it would seem that the statute which gives the highest duty, the largest fees, or the severest penalties, is never repealed by a later act which mitigates the penalty or diminishes the fees. Acts giving certain fees or forfeitures to certain officers become almost like the laws of the Medes and Persians, incapable of being repealed. At least, it is hard for human ingenuity to discover language for the purpose, which may not be perverted by ingenious misconstruction.

This case raises the question of the construction of an act of Congress, which declares that "The owner, master or captain, or other persons employed in navigating canal boats without masts or steam power, &c., shall not be required to pay certain fees, nor marine hospital tax, and shall receive no benefit from the marine hospital fund," &c.

It is well known as a part of the history of the act of Congress, that it was originated at the instance chiefly and for the relief of a certain class of citizens of the Commonwealth of Pennsylvania.

Much of the internal trade of this country, which was formerly carried on by wagons, over turnpikes or by coasting vessels trading from port to port, is now carried on by means of canal boats. In the transportation of coal, these boats are loaded among the mountains, dragged by horses or mules down to the harbor of Philadelphia, towed from the harbor to the New Jersey canal, again dragged by animal power, to be again tugged or towed into the harbor of New York. The trade thus carried on is entirely internal, as much so as if done by wagon or railroad car, and calling as little for the interference of the revenue laws. There is nothing of a maritime character about this mode of transportation, save the boat. The persons who conduct or navigate them, the steersman of the boat, his assistant, the man or boy who drives the mule, have probably never seen the sea till their arrival at New York. They are, therefore, astonished to find that, as soon as their boat touches brackish water, it has become the subject of a new code of laws, originating in Rhodes or Italy, and in the tales of Oberon and Rhe. That these mountaineers have, by magic, become mariners; that they may libel the coal boat for their wages, or hypothecate it for oats and provisions, on the return voyage, &c., and a thousand other incidents of admiralty jurisdiction, and custom house supervision and fees, which have about as much application to them and their boats as they have to Conestoga wagons.

For the purpose of relieving trade from these annoyances of admiralty law and custom house exactions, this act of Congress was passed, and the question for the court to decide in this case is, whether we can by any ingenuity so construe, or rather misconstrue it as to render it wholly ineffectual.

It is proposed to do it by means of the following stories or syllogisms:

A canal boat is a canal boat only while it continues to be a boat on a canal: and although it has no mast or steam engine on board, yet when a steam tug is attached to it by a rope for the purpose of taking it from part of a harbor or river to another, she becomes *ipso facto* a steamboat, because it has been tugged or propelled by steam, and so remains ever after, it having

lost the character of a canal boat for ever, by a single contact with the rope c a steam tug.

The man, the boy, and the mule are thus converted into mariners, an entitled to libel for wages in admiralty, and to an interest in the marine hos pital fund. Ergo, they are bound to pay the same fees as were exacted befor this law was passed. The objections to this reasoning and conclusion are tha they shock common sense, and annul an act of Congress specially made t apply to these very persons and things.

Consequently the fees exacted from the plaintiff were illegally exacted, an he is entitled to recover according to the conditions of the case.

COALS AND COLLIERIES.

ANTHRACITE COAL TRADE FOR 1857.

	Tons.
Shipments by Reading Railroad, to March 26th	420,235 16
" Schuylkill Canal	17,597 08
Total by railroad and canal	437,833 06
Shipments to same time last year	373,852 00
Increase in 1857, so far	63,981 06

LEHIGH COAL TRADE FOR 1857.

Quantity of coal sent by railroad, to March 21st:

William Milnes & Co.	21,499 02
Ratcliff & Johnsons	13,698 04
Packer, Carter & Co.	14 586 05
New York & Lehigh	9,581 13
Sharpe, Leisenring & Co.	13,863 09
German Pennsylvania Co.	1,100 14
Dobbin & Dehaven	238 13
Hazleton	2,411 17
Total	76,990 17

SCRANTON COAL TRADE FOR 1857.

Shipments for the month of February:

North	Month, 10,480 tons			21,315
South	" 19,114 "			35,069
	29,594	Total		56,384

UNION CANAL RAILROAD COAL TRANSPORTATION.

Amount transported during the month of February, 1857.

	Month	Total.
Union Canal	8,431 15	18,394 00
Swatara Railroad	6,948 00	11,058 10

RATES OF TOLL AND TRANSPORTATION ON RAILROAD, FOR THE PRESENT.

	From Mt. Carbon.	S. Haven.	Pt. Clinton.	Auburn.
To Richmond	$1 80	$1 75	$1 55	$1 60
To Philadelphia	1 80	1 75	1 55	1 60
Spring Mills	1 55	1 50	1 35	1 40
Reading	1 10	1 05	1 05	1 05

RATES OF TOLL BY CANAL, FOR THE PRESENT.

	From Pt. Carbon.	Mt. Carbon.	S. Haven.	Pt. Clinton.
To Philadelphia	65	64	62	50
Spring Mills	60	59	57	50
Norristown	55	54	52	45
Reading	38	37	35	31

RATES OF FREIGHT BY CANAL.

	From Pt. C. & Mt. Carbon.	S. Haven.	Pt. Clinton.
To New York	$1 90	$1 85	$1 80
To Philadelphia	90	85	80

RATES OF TOLL AND TRANSPORTATION ON THE LEHIGH VALLEY RAILROAD.

Mauch Chunk to Trenton		2 00
do	Elizabethport	2 43

CUMBERLAND COAL TRADE TO MARCH 28TH.

By Cumberland Coal and Iron Co's. Railroad.

	tons.
Cumberland Coal Co.	23,946 01
Percy & Co.	000 00
Ætna Co.	3,379 11
Total	27,325 12

By Cumberland and Pennsylvania Railroad.

Frostburg Coal Co.	3,833 13
Borden Mining Co.	7,690 14
Allegany Coal Co.	5,361 02
Wellersburg Coal Co.	174 11
Carbon Hill Coal Co.	
Union Coal Co.	
Total	17,060 00

By George's Creek Railroad.

George's Creek Co.	15,886 17
Swanton Co.	2,531 00
American Co.	12,787 12
Franklin Coal Co.	6,852 02
Lonaconing Co.	55 09
Pickell Coal Co.	3,809 19
C. E. Detmold	4,669 06
Preston Coal Co.	
Total	44,005 16

By Hampshire Coal and Iron Co's. Railroad.

Hampshire Co.	13,507 07

DELAWARE AND HUDSON COAL COMPANY'S ANNUAL STATEMENT.

The following statement shows the operations of the Delaware and Hudson Coal Company for the past year:

To coal on hand, March 1st, 1856		801,881
Mining coal		331,550
Railroad transportation and repairs		303,246
Canal repairs and superintendence		249,820
Freight of coal to Rondout		490,482
Labor and expenses at Rondout		66,752
Rent, salaries, current expenses, &c.		29,284
Coal yard and harbor expenses, taxes, interest, &c.		202,674
Depreciation account		25,000
Together		2,500,693
Sales of coal to March, 1857	2,286,008	
Canal tolls	584,750	
Coal on hand	741,293	3,562,051
Resulting profits		1,061,358

The profits of the year are 15 per cent. on a capital of $7,500,000.

The above shows a very prosperous statement of the affairs of the com-

pany. The tolls received principally for coal passing through their canal fro the Pennsylvania Coal Company, ($584,750,) more than pays all the curre expenses of keeping the canal in repairs, expenses of transportation over ar repairs of their railroad, and all the rents, salaries, &c., of the company.

TABLE OF THE WEEKLY SHIPMENTS FROM THE FOLLOWING POINTS IN 185 WHICH WE PUBLISH FOR REFERENCE.

		Schuylkill.		Lehigh.		Delaware & Hudson Canal.	Pennsylvania Coal Company.
		Railroad.	Canal.	Railroad.	Canal.		
March	15, ...	26,405					
	22, ...	29,100					
	29, ...	33,172					
April	5, ...	41,610		up to			
	12, ...	53,148	14,246	15,816			
	19, ...	51,056	33,434	2 599	7,988		
	26, ...	49,033	33,111	2,508	16,089		
May	3, ...	43,170	31,277	2,348	33,128		
	10, ...	40,410	31,276		32,378		
	17, ...	47,262	32,421	3,187	28,999	8,007	8,133
	24, ...	46,573	36,763		39,311	21,828	19,409
	31, ...	48,136	35,935	4,906	41,459	22,184	15,264
June	7, ...	54,353	39,194	3,590	46,790	19,800	24,312
	14, ...	47,628	39,524	3,602	49,541	23,083	27,364
	21, ...	53,045	41,165	4,455	42,429	16,196	17,138
	28, ...	54,770	34,028	4,110	40,258	21,893	27,123
July	5, ...	54,962	27,109	3,744	35,584	18,191	20,488
	12, ...	29,043	33,562	3,172	43,186	21,093	28,312
	19, ...	49,282	32,108	3,773	45,967	20,786	27,524
	26, ...	48,849	31,234	4,627	44,335	20,849	26,388
August	2, ...	49,330	29,490	4,306	44,265	20,674	25,641
	9, ...	46,006	25,807	5,096	28,466	17,194	26,515
	16, ...	51,728	30,322	4,004	43,785	18,625	23,729
	23, ...	45,345	28,823	5,553	40,969	14,726	13,404
	30, ...	53,459	35,901	5,794	38,576	14,981	17,085
September	6, ...	52,830	34,661	5,403	36 213	18,500	27,188
	13, ...	55,773	32,798	5,052	37,615	17,575	27,151
	20, ...	55,629	32,777	6.853	34,716	18,120	20,000
	27, ...	55,888	33,426	6,248	34,973	19,271	26,080
October	4, ...	55,235	32,139	5,127	34,094	18,000	22,430
	11, ...	53,072	84,665	3,957	37,891	17,976	17,701
	18, ...	49.069	30,642	6,943	32,952	16,314	21,695
	25, ...	52,131	32,795	5,513	30,921	14,100	22,486
November	1.	51,566	35,521	6,216	34,976	16,105	21,303
	8, ...	40,994	28,769	4,880	28,962	14,371	
	15, ...	38 519	37,910	5,456	31,456	14,452	17,047
	22, ...	29,768	36,970	4,027	33,808	11,078	17,878
	29, ...	51,851	34,026	6,007	19,345	7,391	
December	6, ...	47,639	32,195	2,146	5,551		
	13, ...	50,514	18,174				
	20, ...	47,046					
	27, ...	23,760					

CALLAWAY MINING AND MANUFACTURING COMPANY OF MISSOURI.

Annual Report of the Board of Directors.

At the date of thelast Annual Report, the Directors were sanguine of havi the work then in progress, completed, and productive early in the followi spring. But owing to the unprecedented severity of the winter, combin with other causes, over which the Directors had no control, it was delay until the middle of the summer. Much of the unfinished work was left the contractors in a situation to sustain considerable damage, which, in a dition to delaying its completion, added considerably to its cost.

The railroad was finished in July, but at too late a date for the compa to realize from sales of coal to the river steamers, in consequence of the u usual low stage of water (which was not confined to the Missouri river alon preventing all the large class, as well as many of the smaller boats from ru ning, a business from which the Directors had reason to anticipate a lar profit.

The locomotive sent out by Messrs. Richard Norris & Son, arrived at the company's landing on the 17th of May, and the company was then prepared with a sufficient number of cars to commence business at that time, as they had about six thousand tons of coal mined, and ready for market. They commenced bringing coal to the landing on the 15th of July, but the whole amount realized from sales up to the end of the year was short of $600! Thus showing very conclusively, that in order to make the work productive it will be necessary for the company to provide means for transporting their coal to St. Louis, where it will at all times command a ready sale at prices leaving a large margin for profit.

It can be transported by railroad or river, but either mode will require an outlay on the part of the company beyond the power of the Directors to provide for.

The highest estimate for transportation to St. Louis, by river (a distance of 160 miles), is one dollar per ton; but should it prove to cost double that sum, it could even then be placed there at about 20 cents per bushel, or $6 per ton below the regular price of Pittsburg coal in that market.

The amount realized by the issue of the mortgage loan would have been sufficient for the requirements of the concern, could the work have been completed and made productive previous to the maturing of the interest, the payment of which deprived the Directors of the funds they so much needed to complete the work. It was deemed advisable to raise funds by the issue of the reserved stock of the company, and the Directors authorized the officers of the company to send circulars to the stockholders, offering them the stock, *pro rata*, at the nominal price of *ten dollars* per share. But owing to the inability of very many of the holders to comply with the terms of subscription, the whole amount realized was but a little over $17,000, an amount quite insufficient for the requirements of the company.

The Directors having exhausted their resources, it now becomes necessary, *and imperative*, for the stockholders to furnish means by subscription to stock, or otherwise, sufficient to pay off the *floating debt*, and to provide the requisite transportation property for sending coal to St. Louis.

Provision will also have to be made for the payment of coupons due March 1st, amounting to $12,500.

At a special meeting of the stockholders, held on the 22d of January, the following preamble and resolutions were prepared, and are now submitted for your consideration:

Whereas, the present *crisis* in the affairs of this company calls for the full knowledge and the united action of both bondholders and stockholders;

Resolved, That in order to SAVE THE STOCK FROM TOTAL SACRIFICE, an early and universal effort on the part of the stockholders to meet their *pro rata* of the sum needed, that they ought to relinquish a portion of their stock, in order to save the rest.

Resolved, That in the event of the failure of this effort to *protect* the stockholders, it be recommended to the Directors to execute a *second* mortgage, and authorize its negotiation by the Board, by pledging as collateral security the stock belonging to the company, with a privilege of its being taken by the subscribers to the said second mortgage loan, in payment therefor, at such a price as may be agreed on.

On motion of Mr. Kennedy, seconded by Mr. Cross, *it was Resolved*, That the Directors be authorized and requested to call a meeting of the stockholders, in accordance with the Charter and By-laws, for the purpose of taking in consideration the foregoing preamble and resolutions.

The plan originally adopted for mining, by stripping or uncovering, has been *abandoned*, the top soil being of such a character as to render it *impracticable*, and a TUNNEL has been commenced, at the proper level, which, when completed, will insure a regular supply of coal at all seasons of the year.

The Treasurer's accounts show the receipts and disbursements for the year.

The undersigned finding it impossible to devote the time and attention to the business, that the interest of the company required, he gave notice to the Directors as early as November last, of his wish to be released; he must, therefore, beg leave to decline a re-election.

Respectfully submitted, by order of the Board.

FRANKLIN A. COMLY, *President.*

Office Callaway M. and M. Co.
Philadelphia, February 5th, 1857.

DESCRIPTION OF THE COMPANY'S PROPERTY.

This company owns, in fee simple, and free from all incumbrance, about three thousand acres of land in Callaway County, Missouri, which has been selected with especial reference to its great mineral wealth, and embraces large masses or veins of Cannel and Bituminous Coal, iron ore of a rich quality, fire-clay, limestone, &c. The lands are situated on and near the Missouri river, about one hundred and twenty miles above St. Louis, and within twelve miles of Jefferson City, the capital of the State.

The coal beds are from three and a half to five miles from the river, and the openings are one hundred and eighty feet above its level, to which there is a gradual descent from the mines. The coal has been penetrated in one place near the outcrop, and found to be twenty-four feet in thickness; and in another place, three and a half miles distant, and found to be seventy-five feet in thickness, of solid Cannel Coal, of the first quality.

Examinations have developed deposits of coal heretofore unknown, and in apparent great magnitude, as the following report by the Engineer shows: "In a ravine, in N. W. of Sec. 24, there are three openings about seven hundred feet apart; in the first the coal is over 32 feet thick, with a slate covering 8 feet thick, and dips, as do all of them, towards the hill, at about one foot in seven. In the upper opening three borings have been made into coal 45 feet thick, with a covering of sandstone and slate 28 feet thick. And the various outcrops along the ridges, for several miles N. E. and S. W, in regular range, indicate an extraordinary amount of coal. From calculations, an amount of over 300,000 tons of coal is bored into, and known to exist in a space less than ten acres, or equal to about one hundred millions of tons in the Company's lands."

It is supposed by geologists to underlie the whole surface, and to be the largest body of Cannel Coal in the world, This tract also embraces about three hundred acres on the bank of the Missouri river at Cote Sans Dessein, valuable for depots and landings, and probably for a large town, as it is the only high ground for twenty miles up or down the river, a rock foundation, entirely above high-water mark, and consequently neither subject to overflow nor to be undermined by the current.

The improvements consist of a first-class railroad seven miles long, extending from the river Missouri to the mines, fully equipped with locomotive and coal cars; also a steam saw-mill and grist-mill in good working order, and several houses for the accommodation of agents, miners, laborers, &c.

The advantages possessed by this company must be apparent on the mere recital of their prominent features, and present inducements for the investment of capital rarely to be met with. Inexhaustible beds of Cannel and Bituminous Coal, of the finest quality, lying contiguous to navigable waters of vast extent, traversed by hundreds of steamboats requiring coal for fuel, and furnishing cheap transportation to the numerous foundries, manufactories and gas works at St. Louis, New Orleans, and other western cities, for all of which purposes and the manufacture of Kerosene Oil the coal is admirably adapted (to say nothing of the demand for parlor and domestic use, for which it is highly approved), together with the richest iron ore and other minerals necessary for the profitable manufacture of iron, constitute the sources from which, with judicious management, under a liberal charter, rich returns are confidently expected.

For more full particulars reference is made to the charter and accompanying documents.

EXTRACT FROM THE REPORT OF PROF. G. C. SWALLOW, STATE GEOLOGIST OF MISSOURI, 1855.

"There are, also, in this State (Missouri) many very remarkable and important deposits of coal, which are referred to the regular Coal Measures with some degree of hesitation, as we have as yet found no positive evidence of their true geological position. These formations are made up of beds of Cannel and common bituminous coal (the same bed often containing both varieties), and a few unimportant strata of shales. These coal strata vary in thickness from one to thirty-six feet (the famous bed in Callaway near Cote Sans Dessein, is said to be eighty feet thick), while the accompanying shales are very thin. All the Cannel coal observed in the State belongs to these irregular deposits.

CANNEL COAL MINES, Callaway County.

This is to certify that I found, upon the opening called the Mastodon bed, a shaft sunk to the depth of 46 feet (at present 75 feet) of solid Cannel coal of the best quality, and not reaching through to the bottom of the vein. On taking the dip, from the inclination of the layers in the shaft, I found it to be one foot in three; I then sunk a shaft 85 feet to the north-east, and reached the coal at the exact depth required by that dip; thus determining the direction and dip of the vein. I also found at the opening known as the Mammoth bed, a shaft sunk to the depth of 24½ feet in solid Cannel coal, reaching through the vein where it crops out; and from excavations which I made to the south-west, reaching the coal, and as the associated rocks and minerals appear to be identical at the two openings, I am satisfied it is a regular formation, underlying the lands between the two points. I also visited three other openings of Cannel coal, and two of blacksmith's or bituminous coal, one of which is 7 feet thick, all lying on your lands, and within the basin between the two large openings.

I have been engaged in mining coal and iron ore for 27 years past, in Scotland and in this country, and I never saw or heard of such extensive prospects of Cannel coal in any country. The last work I did in Scotland was on a vein of Cannel coal in Lennoxshire, of 22 inches in thickness.

The quality of the iron ore found on the lands and in the vicinity is excellent, and can be obtained in large quantities; and there is abundance of limestone, sandstone, and fire-clay contiguous to it, water sufficient; and I am of opinion that iron can be manufactured here as cheaply as at any place I am acquainted with.

Yours respectfully, &c.,
DAVID PERCEY, *Master Miner, of Frostburg, Md.*

THE COAL TRADE.

We copy the following article upon the present condition and future prospects of the coal trade, from the Pottsville Journal of March 28, 1857.

The quantity sent this week is not as heavy as was anticipated by many, and as far as we can learn, the coal is all sold at fair prices. Nearly every operator shipping by canal had orders for a few cargoes of fresh coal, to be shipped as soon as the canal opened, for points reached by boats, which they are shipping. The demand at Port Richmond is also improving a little—but all are anxious to push off the old stocks before they are willing to receive coal; consequently the trade must necessarily remain dull for some time yet. The trade is a little in advance of last year, and this has a tendency to check it also.

Operators representing three millions, of the 3,818,000 tons shipped last year, by resolution have given Mr. Tucker unlimited authority until the first of May, to curtail shipments to any extent the exigencies of the trade may require—they also resolved, unanimously, to request the carrying companies to co-operate with Mr. Tucker in sustaining the trade, so far as it is in their power to do so. So unanimous a request on the part of those who furnish the trade, and whose interests are identical with the carrying companies, in sustaining each other, that it *must be taken into consideration, and cannot be rejected, except for reasons which are beyond their control, and which they cannot comply with.* And besides, it will be to the interest of the companies to do so. The trade opens dull—under such circumstances purchasers expect coal extremely low. A certain interest opposed the Coal Association—or whose interest it is to obtain coal at the lowest rates, as long as they can, regardless of cost,—are busy in creating such an impression—and we are credibly informed that circulars have been sent into distant markets, offering coal on board at Richmond at rates which would cause a loss of at least 25 cents per ton to the producer. This causes uncertainty to the purchaser abroad—and so long as he expects coal to go lower he will not purchase. *This was one of the great difficulties which the trade was forced to encounter throughout the whole of last season*, affecting the business of the carrying companies very materially also. If not removed, it will affect them equally with the coal trade this year, and will deprive them of at least two hundred thousand tons of transportation, even at the present low rates of toll—as the supply from this region must inevitably fall short at least that quantity. With the co-operation of the Railroad and Canal companies the whole question is at once settled—the trade abroad can come forward and make their purchases advisedly and safely. There will be a security given that will remove all doubt at once—and both the Delaware and Hudson Company, and the Pennsylvania Coal Company, who have not yet fixed their prices, will conform to the arrangement—they having pledged themselves to do so. If our prices are forced down in the mean time below the paying point, their rates will be fixed accordingly, and the whole trade will be committed to the waves of the different conflicting interests again, without a pilot, and without any hope of being saved from almost total ruin. Some may survive the general wreck, but the large mass, who have every thing invested in mining operations, will have but little hope of escaping. The next step downward is total ruin.

The reason why the coal operators are desirous to secure the co-operation of the carrying companies, is simply this:—Men sometimes are extremely desirous to do what they believe to be for their intersts—but their pressing circumstances and the *imagination* of difficulties, (which, in many instances, are greater than the *reality*,) cause them to commit many unwise acts, which they deprecate afterwards. A little controlling power, exerted by an organization for mutual interests, benefits such persons, and prevents injury to others. We read of an instance a short time ago which sufficiently illustrates this point. A person in one of our cities felt a strong and intense desire to get married. He knew it would be improper to do so, but his propensity was so strong and pervading, that he did not trust himself, and he advertised for some friend to call upon him and dissuade him from doing so improper an act. Many of our coal-operators are placed in a similar position from their necessities, and they desire to be placed in a position by which they will be restrained to some extent from doing what they know would be injurious to themselves and their neighbors.

It has become a common practice to vilify and denounce our coal operators. In some instances the censure may be deserved—but as a class, we believe that they are as honest and trustworthy as any other class of business men. The trade in which they are engaged has been truly unfortunate and embarrassing, from causes which have been freely discussed from our columns—and we doubt whether there can be found a body of business men, who bore up as well as they have done, under a similar pressure of circumstances. The

coal organization was originated to curtail and lessen many of the greater evils.

It may surprise some, but it is nevertheless true, that the coal trade never has nor ever will prosper, without being controlled by some means or other. Many of the evils are inseparably connected with this trade, and lie in its precarious, and we may say, almost reckless character—we cannot see into the bowels of the earth one inch in advance—and hundreds of thousands of dollars invested in a shaft, a slope, or a rock tunnel, may be totally lost by the discoveries of a single day. This is the character of the mining business every where. The whole history of the coal trade of Europe substantiates what we have stated—bankruptcy after bankruptcy has always occurred whenever the supply was not kept within the demand by mutual organization of the trade. Such must be the characteristics of the trade wherever it is carried on to any extent—and view it in any aspect, organization for mutual protection is the only hope for its prosperity—and the only mode by which a regular supply can be secured to the consumers at reasonable rates.

Not a single new colliery has been started, as far as we can learn, in this region, within the last year, although this county has heretofore supplied one-half the anthracite coal sent to market; and a number of collieries are standing idle. This does not arise from unfavorable location, because, in many respects, it is more favorably located than any other, and furnishes as good coal, but it is owing entirely to the depressed state of the trade. In truth, a man would be looked upon as almost insane to deliberately invest a large sum of money in any colliery, without an organization of the trade on which he could rely, either here or elsewhere, in the present state of the trade.

It now rests, in a great measure, with the Philadelphia and Reading Railroad Company, and the Schuylkill Navigation Company, to decide whether it shall be carried out effectually and unanimously or not—and all doubts removed as to the future state of the trade. It is no ordinary question, and ought to be well weighed in all its bearings, now and for the future. By sustaining the producers, they sustain themselves—by prostrating them, they cannot expect to escape without serious injury to their own immediate interests. The whole trade of Schuylkill County are anxiously awaiting their decision.

Since the above was in type, we have learned that "the managers of the Reading Railroad will co-operate with the trade."

TUNANGWANT COAL AND IRON—NORTH-WESTERN PENNSYLVANIA.

Dr. Owen, of New Harmony, Indiana, one of the most distinguished geologists of the day, and Professor Needham, of Scranton, who has had more than thirty years' experience as a geologist and mining engineer in the mineral regions of Northern Pennsylvania, were employed for several weeks during the past autumn in examining the mineral lands on the head waters of the Tunangwant and its tributaries in McKean County, Pa., with which the portion of the Buffalo and Pittsburg Railroad, now being constructed, will, it is understood, bring our city into communication some time during the ensuing summer, by means of other roads with which it will form connections.

We have been favored with an examination of a synopsis of the report made by these gentlemen, accompanied by a drawing of a vertical section of the hills containing the minerals, showing the various strata or veins of coal and iron ores, in their relative positions with the intervening rocks, fire-clays, etc., together with an analysis of the different coals and iron ores as made by Dr. Chilton, chemist, New York, some time last fall, and more recently by Dr. Owen himself.

The introduction of these minerals into our city is a matter of so much importance to us, and now it is hoped so near at hand, that we cannot, perhaps, devote a portion of our space to-day to a subject more generally acceptable to our readers.

That portion of the great bituminous coal field of North-western Pennsylvania, embracing the lands forming the subject of the report now under consideration, occupies an extensive plateau whence arises numerous branches, giving origin to the Tunangwant, the Tuanette, and the Kenzua Creeks.

The two former come together at or near the base of the hills, forming the main Tunangwant, which, flowing northerly, empties into the Alleghany river, about twelve miles below Olean, in the county of Cattaraugus, N. Y., while the latter stream rises further to the east, thence flowing in a westerly direction, empties into the Alleghany below Warren, Pa.

The valley of the Kenzua is deep and wide, completely separating the veins of coal and iron, leaving some seventy or eighty, and possibly a hundred thousand acres of mineral lands to the north of it. The elevation of these table lands is from six hundred and fifty to seven hundred feet above the valley of the Tunangwant at the State line. The branches commence descending rapidly from the summit, cutting out for themselves deep valleys, thus affording every desirable facility for the construction of branch roads throughout the coal measures, while at the same time they give access to the various strata of minerals by means of horizontal drift.

The report describes four workable veins of coal—one of four, and three of about five feet each, one of which is what is called "Cannel Coal," and the others "Bituminous," differing somewhat in quality, as shown by the analysis, all shown to be of excellent quality, some of it superior, as we judge by the comparisons made with bituminous coals of other parts of Pennsylvania, Ohio, Virginia, Kentucky and Great Britain.

There are also four veins of iron ore, varying from one and a-half to five feet in thickness. The three principal veins are described as the "Black Band," containing 43·75 per cent. of iron, the "Gray Fossiliferous Carbonate," and the "Hematitic" ore, containing from 35 to 40 per cent. of iron. These ores compare favorably with the ones of Great Britain, which it is well known are so extensively worked. On looking over a table of the analysis of the ores, used at eight of the principal Iron Works of England and Scotland, we find them to range from 28·01 to 41·41 per cent., among which are the celebrated Black Band ores of Scotland.

These mines of coal and iron are within 85 to 90 miles of this city by the direct route, and will be introduced as we have before intimated, during the coming summer, by means of the roads now in progress of construction from the mines to the New York and Erie Railroad, a distance of some twenty miles, thence over the New York and Erie to Dunkirk, fifty-two miles, and from Dunkirk to Buffalo, by the State Line Road, forty-one miles, or by water, during the season of navigation.

The distance from the mines to this city, via Dunkirk, is one hundred and thirteen miles. This is some 27 or 28 miles greater than by the route contemplated for the Buffalo and Pittsburg road, and when that road shall be completed, it will lessen the cost of transporting coal and other commodities about fifty cents per ton. But we regard the introduction of the coal and iron of the Tunangwant into our city at an early period, in any manner, however imperfect, as a matter of vital importance, believing that when that is once accomplished, these means will be perfected, so that ere long we shall have all necessary facilities for obtaining them at the lowest possible cost.

This report also mentions large quantities of Fire Clay, of excellent quality, suitable for the manufacture of fire brick, and sandstone in great abundance, of the kind employed in the manufacture of flint glass.

These materials, when brought together into a city like Buffalo, will be of inestimable value in building up manufactories, and we congratulate our citizens on the golden prospect before them.—*Buffalo Commercial Advertiser.*

DEVELOPMENT OF THE MAMMOTH VEIN IN THE SOUTHERN PORTION OF THE SCHUYLKILL COAL BASIN.

The impression has long existed that the Mammoth Vein underlaid th-

whole region, extending through the series of basins running from the Broad Mountain in the north, to the sharp Mountain in the south. Mr. McGinnes first successfully established the theory that this celebrated white ash vein was accessible at the saddles of the basins while traversing the region, and this fact at each successive proof of its truth, tends to enhance the value of lands in the southern portion of our coal basin. It was thought that the Mammoth Vein as it ran south into the lower basins would, when opened, be found crushed, and not prove so valuable as it is at the Broad Mountain. The fallacy of this impression is fully established, by the shaft at St. Clair, by the boring on the North American coal track, by the evidences of the vein in the 3d basin, and finally, by the opening of the Mammoth Vein, by Messrs. John G. Hewes & Co., owners of the Eagle Hill track (316 acres), in the centre of the great Schuylkill Coal Basin, 2½ miles above Fort Carbon, and ¾ of a mile below the most southern opening of the Mammoth's Vein up to the period of its opening on the Eagle Hill track. The opening in this instance has been effected on the north anticlinal of the Peach Mountain Basin, —also known as the 5th Basin of the series.

By a very nice mathematical calculation, Mr. Hewes bored down to the vein, and struck it on the saddle. After striking the vein, Mr. Hewes sank down on the Black Heath, or 7 feet vein, which pitches at about 80 degrees. We went down 100 yards with a pitch at bottom of 78 degrees. A tunnel was then driven south 75 feet to the Mammoth Vein, which has a pitch of 58°, and is only 5 feet where cut, evidently in a pinch, being on the north pitch of the basin. In the upper side of the gangway, however, it widens out and increases in thickness so rapidly, that at 44 feet up the pitch there are 14½ feet of splendid coal, including 3 inches of slate over the bottom bench. Upon inspection of the coal at the mine, we found it as pure as any at the Broad Mountain. At the face of the working, on the Eagle Hill Track, the pitch of the bottom slate is 40°, regular and undisturbed, while the top slate has a pitch of 60°. By driving a few yards further, present appearances indicate that the vein will widen out to the usual thickness, between 20 and 30 feet. By driving the east gangway a few yards, Messrs. Hewes & Co. will get into this thick coal, as the basin inclines east. An interesting fact in connection with this opening is, that the 7 feet, or Black Heath Vein, overlaying the Mammoth on which they sunk, crops out at surface right over the saddle, at a distance of only about 30 feet from the outcrop of the southern pitch of the same vein, leaving a space sufficient between to erect the necessary power to work both slopes north and south. Immediately under the Mammoth lies the Skidmore Vein, which contains 12 feet of beautiful coal, now worked by Mr. Guiterman. We append a rough representation of the situation of the veins, which will enable the reader to understand their position better than by a simple description:

The shaft on the 7 feet vein is sunk to the depth of 300 feet at the point where they started the tunnel north to strike the Mammoth Vein. They propose extending this tunnel south so as to cut the southern pitch of the Mammoth a distance of 171 feet, and also the south dip of the 7 feet vein, which would be 75 feet further. They can then run up a slope on the south dip of the 7 feet vein, and work this colliery from both slopes. The tunnel cut across at the bottom of the slope would also cut the north and south dip of the Skidmore or 12 feet vein, which also could be worked from the same opening. The extent of breast on the north pitch of the 7 feet vein would be 300 feet; on the north pitch of the Mammoth, about 180 feet; on the Skidmore, about 100 feet. On the south pitch, which is not so steep, it would be about 150 feet on the Skidmore, 300 on the Mammoth, and about 400 feet on the 7 feet vein, making one of the most extensive white ash collieries in the region, only 2½ miles from the landings, from which the coal can be delivered in the cars at Mount Carbon, for only 16 cents per ton transportation. The Schuylkill Valley, which has been going backwards for some time past, ought evidently to begin to look up again.

Messrs. Hewes & Innes, who have been active in making this development, which has consumed a year's time, and considerable means, deserve much credit for the addition they have made to the knowledge possessed of the condition of the Mammoth Vein in the various basins of the series. By its development in the 5th basin, this splendid white ash coal is brought nearer to a market where its purity must always command for it ready sale. A year will probably elapse before the vein will be properly opened, suitable machinery erected, and the necessary improvements put up at the Eagle Hill Track. When worked it must prove most profitable to all interested, as the coal is a splendid article.—*Pottsville Miner's Journal.*

IRON AND ZINC.

SIDELING HILL MINES.

The explorations on the eastern borders of our county, and to which we called attention some few weeks since, are still progressing, and the results, we understand, are quite promising. The ores opened up, as analyzed and experimented on in the east, are represented to be varieties of the hydrated red oxide. The parties interested in these lands are resolved upon extending their researches until the true characteristics of these metallic deposits are correctly ascertained, and we doubt not but this will be in the course of a few more months. Two different sets of miners and laborers are at work on the estates we have before referred to as belonging to separate and distinct parties; the one resident in this country, the other in England, and the products in ore that they have already raised to the surface from numerous shafts and drifts along the slopes of Sideling Hill, will amount to some 600 or 800 tons. Examinations are also being made to determine correctly the true nature and practical value of the carboniferous deposits which in this range of country have been, by some, supposed to be anthracite coal, sufficiently thick and pure for working. We hope to be able to speak positively and favorably in some future issue on these new mineral developments.—*Cumberland Civilian.*

IRON MANUFACTURE AT LAKE SUPERIOR.

A recent issue of the L. S. *Journal* furnishes the following on this subject:—The transactions in iron are, for the past year, though small in comparison with what can and will be done, exceed by far the anticipation of those interested. The business has been commenced and the ore successfully introduced into market, where it sells readily at high prices, and all that is now needed is careful and judicious management to insure a lucrative and profitable business.

The shipments for the year were, for the Cleveland Iron Mining Company, 6,536 gross tons, and the same have now on the docks ready for shipment, 3,500 gross tons, making a total of 10,036 tons mined; for the Sharon Iron Mining Company, 4,497 gross tons, and the same have now on the dock ready for shipment, 1,085 gross tons, making a total of 7,302 tons mined. The exact amount taken out by the Eureka Iron Mining Company we have not been able to ascertain; but from our estimates, which are probably liberal, they have shipped 2,000 gross tons, and have some 600 gross tons ready for shipment, giving them a total of 2,600 tons mined. The whole amount shipped being 13,033 gross tons, which, at $5 per ton, the lowest price we have heard put upon it at the dock, would be $102,690. The shipments may look small, but it should be remembered that this is the first really active season, and was the finishing-up of the experimental work. When this is taken into consideration, with the fact that the trade has been established upon a firm basis, it is highly gratifying. From the preparations now making by the companies already in operation, and by others, which will commence in the spring, we estimate the shipments for this year at 200,000 tons. This amount, at the price before named, would net the various companies over $1,000,000! Those are large figures for a small town; yet they are short of, rather than over the truth, and are destined to be largely increased!

EXTENSION OF FRANKLINITE IRON MANUFACTURE.

The *N. Y. Tribune* says, that arrangements are now being made to extend the manufacture of Franklinite iron in New Jersey. This ore is peculiar in its combination, and by reference to scientific works it will be seen that it is no where found except in Sussex County, in that State. It is shown by analysis to be composed of iron, manganese and zinc, in chemical combination. The zinc is driven off in small furnaces, and collected; the residuum is then put into a small blast furnace, about twenty feet high, and run down into pig metal. The fuel used is anthracite coal. The white zinc oxide sells for about $120 per ton, and the pig metal for $40.

We notice that a patent has recently been taken out for smelting the Franklinite, in connection with hematite and magnetic iron ores. Dr. Jackson reports that there are in Mine Hill *three millions of tons* of this ore, above water level. The mining of this ore will require no pumps, till they get down about 150 feet from the outcrops.

CASTING METALS.

Mr. Henry Adcock, of London, has provisionally specified an improvement in casting iron and other metals, which consists in employing highly heated moulds, to be thus heated:—Sand moulds are to be made in the ordinary manner, and then placed in an ordinary muffle, but at some inches above the bottom, so that the drying may be by the moulds being heated on all sides, and at the bottom by the heated air therein. After the drying process has been carried on sufficiently long for the moulds to be gradually dried, and the moisture to be dispersed from them, the fire is to be increased until the moulds are brought to a very high degree of heat; the iron or other metal, is run into the moulds, and then the oven or muffle, together with the moulds and castings therein, are to be allowed to cool down.

MANUFACTURE OF ZINC.

Messrs. G. and J. Darlington, of London, have provisionally specified some improvements in the manufacture or production of zinc or spelter. They take the ores of zinc, either blende (sulphate of zinc), calamine (carbonate of zinc), or any of the other varieties of zinc ores, and after pounding or crushing them to a proper degree of fineness, admix them according to their several compositions, as it may be found necessary, with any or all of the following substances—that is to say, lime, limestone, lapcinder, or any natural or artificial product yielding silicate of iron, silica, or siliceous matter, oxide of iron, or iron and coke, or any other suitable carbonaceous matter. The ores and the admixture, made of any or of all the foregoing substances, being placed in a reverberatory furnace, or mixed with the fuel of a blast furnace, are to be exposed to a sufficient degree of heat to effect the chemical reactions necessary to the production of the oxide of zinc. They then cause the oxide of zinc to be passed through a fire, either enclosed in a furnace, or in tubes made of clay or any other suitable material; these tubes to be of any number or size, and to be placed horizontally, inclined, or vertically, and the production of metallic zinc to be effected by causing the oxide to be passed through such tubes in contact with coke, charcoal, coal, coal tar, vapor, or any other convenient agent. The temperature necessary for the reduction may be obtained by the application of external heat, or in such other manner as may be deemed more fitting; the zinc vapors from the apparatus above described to be condensed by means of a suitable arrangement for the purpose.

MR. BESSEMER'S IRON PROCESS.

The evidence appears to be accumulating, that the process of Mr. Bessemer in the treatment of iron, is by no means so valuable as has been claimed. Dr Macadam has given to the Scottish Royal Society of Arts some reports of experiments, which go to show that the process is ruinous to the metal when carried on for a long period, but may be of service in partially decarbonizing the pig. A furnace was charged with 1,492 pounds of number two pig iron, and the air forced in at a pressure decreasing gradually from fifteen to five pounds per square inch, for eighty-nine minutes, after which the scintillation still continuing, the furnace was tapped and the iron run into moulds; the quantity thus moulded together, with what was thrown out by the violence of the ebullitions, was only 630 pounds, showing 862 pounds to have disappeared in the operation. On attempting to roll the metal it was "hot short," and no subsequent effort at annealing it was successful. Another furnace was charged with 784 pounds of number one pig, and treated as before, but tapped after thirty minutes; the product or bloom was capable of being rolled, but was still, after re-heating and re-rolling, very crystalline and brittle. This iron was pronounced "cold short." Another trial with a number one pig, treated 24 minutes, gave a similar result to the last. One trial was made with number four iron, but in fifteen minutes the metal settled down in the furnace, and though it was immediately tapped, the iron would not run out, and the furnace had to be taken to pieces to liberate its contents. These experiments would appear to be quite conclusive in regard to the inutility of Mr. Bessemer's process.

NEW ROLLING MILL AT READING.

We are pleased to learn, says the *Berks County Press*, that the Keystone Forge, of Messrs. Snell, Mullin & Banford, proprietors, have taken into partnership Mr. Henry McCarty, and intend adding, at an early day, to their present iron works, a rolling mill, the manufacture of railroad axles, and every variety of flat and round iron. The improvement is situated on Pine street, between 2d and 3d, Reading. The new firm is composed of enterprising men, and merits the patronage of the iron interest. The new mill, it is expected, will be in operation in July next.

LAKE SUPERIOR IRON.

During the progress of the harbor improvement this winter, says the Ontonagon *Miner*, the quality of the above iron has been subjected to a severe test. It is well known that the tenacity of iron is very greatly impaired by cold, and that iron which is quite tough at ordinary temperatures, becomes very brittle, and snaps with a crystalline fracture, if it is too severely tested when the cold is intense. Hardly any use to which the metal is put, requires tougher iron than the bands placed around the butts of piles to prevent their abrasion or splintering from the force of the hammer. When the log is driven to nearly its proper depth, the hammer, weighing 2,300 pounds, drops upon it from a height of 35 feet. Last winter, the ordinary banding was used, and great difficulty was experienced from the breaking of bands. As many as three bands have been broken in getting down a single pile, and very few lasted, when the weather was cold, to put down more than three or four without breaking. They would sometimes break into two or more pieces, and would fly in such a manner as to endanger the persons of the men about the machine. This winter they used the Lake Superior iron, with the most satisfactory results. They have driven in the very worst weather, with the mercury 15 or 20 degrees below zero, and yet have broken only two bands. As many as fifty piles have been driven by a single band, which received no other injury than being flattened and expanded. The iron is soft and fibrous, extremely malleable, and is precisely fitted to all places requiring tensile strength. The appearance of the fracture is different from other iron, not at all crystalline, but very white. The blacksmith remarked that he "never before saw iron that looked exactly like silver."

On the whole, this is perhaps the best practical test of the comparative value of the different irons which has yet been made.

CAMBRIA RAILROAD IRON.

Assistant Superintendent Thomas Seabrook, Esq., in charge of the Western Division of the Pennsylvania Railroad, from Altoona to Pittsburg, in his report to the General Superintendent, Herman J. Lombaert, Esq., for the year 1856—to be found among the documents accompanying the last annual report of the Directors of the Pennsylvania Railroad Company—gives the number of feet of rails removed from the track on his division during the year, including rails worn out, rails broken by broken wheels, and rails broken during the cold weather, and from other causes. And while thus on the subject of iron, and the consideration of the *wearing* properties of rails manufactured at different works named by him, and constituting portions of the track under his charge, he makes this brief but conclusive reference to an establishment which is fast rising into favor among railroad companies that consider and appreciate the worth and advantage of *strength and durability* in iron rails:

"The iron manufactured at the Cambria Iron Works, at Johnstown, has given the *most satisfactory proofs of its strength*, and if the manufacturers finish it with a good wearing head of refined iron, it will make, I think, the *best* American rail that I have seen."

BELLEVILLE IRON WORKS.

These extensive works, situated opposite New Orleans, have become the property of an incorporated Company, with a capital stock of $200,000. A charter has been obtained under the general law of the State, for a period of 25 years. The object of the company is to carry on the Foundry and Machine shop business in all its details, such as the manufacturing of iron, brass, copper and other metals into Engines, Boilers, Machinery, and all other, and such work as is appertaining to and carried on in foundries and machine shops, and upon an enlarged scale. F. W. C. Cook, Esq., one of the former owners and superintendent of the works, has been appointed and will continue as Engineer and Chief Manager.

JOURNAL OF GOLD MINING OPERATIONS.

TREATMENT OF GOLD ORES.

Important and highly interesting experiments for the thorough and economical extraction of gold from its ores, have recently been conducted, both by eminent chemists and practical miners, in various parts of Europe. The results of these inquiries are now before the world, and are exciting no little degree of interest on both sides of the Atlantic, especially among those engaged in gold quartz mining.

These researches and experiments have been principally confined to two leading objects:—1st, the utility or economy of roasting the ores in bulk, before crushing; and 2d, to an inquiry into the nature of the auriferous pyrites, and the best mode of treating them with reference to the extraction of gold which they contain. It is our present purpose to lay before our readers some account of these experiments, and the conclusions arrived at among transmontane and trans-atlantic miners. We propose to consider first the

Roasting of Gold Ores.—The economy of this process is a matter which has attracted the attention of both the scientific and practical miner for upwards of two centuries. As long ago as 1629 Lazarus Erckern, the Assayer General of Germany, published a work on gold ores and metallurgy, in which he took ground against the practice of roasting gold or silver ores, for the reason, that careful experiments had satisfied him that a large percentage of the metal was lost by the operation. Since that time much has been written upon the subject, and, until recently, a very great diversity of opinion has existed among miners and scientific men in England and on the Continent. Modern discoveries in chemistry have very greatly facilitated researches of this description, and such experiments are now conducted in a manner which dispels all doubt as to the accuracy of the results and conclusions arrived at. Under these favorable circumstances, an elaborate series of experiments has recently been fairly and fully tried under the auspices of the Russian Government, and the conclusions drawn therefrom are very decidedly *against the roasting process.*

The official report of these experiments, which were conducted among the mines at Ecatherineburg, states that the ore when roasted in hermetically sealed crucibles, lost 20 per cent. of gold, and 4¾ per cent. of silver. Ore roasted on an uncovered hearth resulted in a loss of *forty per cent.* of gold and *twenty-one per cent.* of silver! The same experiments were repeated at many different mining localities, and every where with similar results. They have also since been repeated in England, though in a less elaborate manner, but still with sufficient exactness to satisfy the experimenters of the general correctness of the result given in the Russian official report.

The following are the published opinions of several practical miners and metallurgists who have devoted much attention to this subject:

"Trehern, at Marmato, roasted the ore in a reverberatory furnace, and though the show of gold was great, it only yielded about one-fifth of what was obtained from an equal portion of the unroasted pyrites.

"Leay, at Marmato, roasted his ore and found he got less gold than he would have obtained by the most ordinary method of the Batea. He roasted his ore to that degree that the color of the slime which escaped in abundance from the stamp pits was deep red-brown, or hematite red.

"Again he found one-third of the gold remained after roasting, in some manner associated with the sulphuret of silver, and other products formed by the process of roasting.

"Degenhardt has an opinion that the gold forms a sulphuret and is perhaps carried off through the chimney, on account of the silver, which formerly

was alloyed by the gold having entirely disappeared during the process of roasting.

"Philips in his 'Metallurgy,' says: Gold is not directly attacked by sulphur at any temperature; but when fused with the alkaline sulphurets is rapidly acted on with the formation of a double sulphuret, in which the sulphuret of gold acts the part of an acid.

"I am fully impressed with the belief that the ore, if ever roasted, will cause you a loss of that gold, which could have been much easier ascertained by simply stamping it, and causing it to pass over mercury or skins.' "—*MS. Correspondence.*

Whether the loss by roasting results from the carrying away of the extremely fine particles of gold by the upward current of air from the burning mass, as a light breath of wind carries off the leaf gold in a gilder's room; or whether some chemical change in the gold occurs by which it is oxidized; or whether the loss results from sublimation, are matters with regard to which there is yet much diversity of opinion. All are agreed, however, that serious loss arises from both the first and third suppositions; but with regard to the oxidization, much doubt exists—although there is great probability that such a chemical change may take place to a limited extent.

Whatever difference of opinion may exist with regard to the causes of loss, the practical question of the economy of roasting is now very definitely settled among European operators in gold ores; and it should be considered a conceded fact among our own miners, that gold or silver ores roasted, either in open heaps or reverberatory furnaces, or in any other manner, will not yield as much ore as a similar portion of the same ore taken from the same heap, and equally rich, will do without being roasted.

EXTRACTING METALS FROM THEIR ORES.

Messrs. Stopford T. Jones (Greenwich), and Josiah Harris (Dolgelly), have specified their invention for an amalgamating machine, to extract gold and silver and to separate iron from crushed mineral ores in water. They make a water-tight hollow case, say, about 5 feet deep by 20 in. square, to amalgamate about 4 tons of crushed mineral ore per day, or larger or smaller, in proportion to the quantity of crushed mineral ore to be treated. Such machines they call an amalgamator; the bottom to be semi-circular. Inside of this case they have one or two fans, one of them having two or more blades; but four are preferred; such blades to work near the bottom with spindle and bearings. Each blade is perforated with numerous holes, and may be turned up at the ends. The other fan is placed above the lower fan, with spindle and bearings, and has also two or more blades, being made of open ribs or bars. One, or both these fans can be used, as most suitable, to the crushed mineral ore to be operated upon. Attached to the amalgamator is a feeder, to convey the crushed mineral ore and water into the amalgamator. The feeder has an opening near the bottom, through which the crushed mineral ore and water pass into the amalgamator, and thereby comes in contact with the mercury with which the amalgamator is charged. The fan or fans, being revolved by any usual gearings, will agitate and mix up the crushed mineral ore, water, and mercury. An opening is made near the top of the amalgamator to allow the refuse crushed mineral ore and water to pass out. At the bottom of the amalgamator is fixed a tap, for the purpose of drawing off the mercury and the gold and silver amalgam. Connected with the feeder they place a series of magnets or magnetic bars, to take up the iron that may be in the crushed mineral ore and water, so as to prevent altogether, or as near as possible, its passage into the amalgamator. These magnets or magnetic bars can be made to revolve or remain stationary, and are so placed as to be removable, changed, and cleaned at pleasure.

Dry Crushing.—Mr. John Walker, of London, has invented an improved description of stamps, by which mineral can be crushed dry with the great-

est facility. Heretofore the chief difficulty in stamping dry has been the great trouble and labor of keeping the bed clean, which is rendered easy by making the stamp's head of a V shape, and providing a bed of corresponding form, so that the ore to be crushed may be fed in both from the back and front of the stamps, passing off immediately under the head. This system will be almost invaluable where water is scarce, and with the inventor's stamping machine for crushing the stones as drawn from the mine, will be a great acquisition in mining operations.

A RICH MINE.

Some five years ago, a company consisting of five Irishmen and one man from Pike County, located on a claim near Alison's ranch, on Wolf Creek, and but a couple of miles from Grass Valley. At first, and for nearly two years, they worked in the bed of the stream and in the banks, making fair average wages. About eighteen months ago they struck a vein of auriferous quartz. A wagon load of it was dug up, crushed, and found to yield one hundred dollars to the ton. They then carried several loads of it to the Gold Hill mill, which yielded one hundred and fifty dollars to the ton, and sixty-two tons of the rock produced as high as three hundred dollars per ton. The company then went to work to erect a quartz mill, which was completed on the first of October last, at a cost of $40,000. Meanwhile some seven hundred tons more were gotten out, which yielded all the way from two hundred and fifty to five hundred dollars per ton.

The lead is from one to four feet in thickness, and increases in width as explorations are made. The cost of crushing the rock is twelve dollars and fifty cents, and the average amount crushed, twenty tons per day. The regular yield of amalgam of this mill is not less than thirty thousand dollars per week; and as the total expenses of running it will not exceed fifteen hundred dollars for the same length of time, it is easy to see what a princely fortune is rolling in upon the fortunate owners of this gold mine. A portion only of their earnings is brought down to the mint for coinage, but, as the subjoined figures show, that "institution" can bear unequivocal testimony of the richness of their claim.

On the eighth of November there were deposited nine hundred and twenty-two ounces; on the 27th, one thousand one hundred and ninety-three ounces and fifty-four hundredths, and on the 13th of the present month, eleven hundred and six ounces, and sixty-four hundredths of an ounce. The original holders of this magnificent claim still retain possession of it, and as might be expected, are totally averse to disposing of shares.—*San Francisco Herald.*

QUARTZ MINING SUMMARY FOR FEBRUARY.

The North Californian, published at Oroville, Butte County, speaks thus encouragingly of quartz operations in that neighborhood:

"There is an abundance of quartz in this county, perhaps as much, and as good, as in any part of the State, but the unfortunate operations of '51 and '52, destroyed all confidence in this kind of mining; and until the past year a miner would hardly take a quartz lead as a gift. We believe every quartz company in the county discontinued operations—most of them by compulsion—with the exception of Messrs. Smith & Sparks, who, by their energy and perseverance, have at last very clearly demonstrated that quartz *will* pay. Their success induced others to renew operations, which have generally been successful also. Now quartz property is in greater demand than any other. Five or six mills are in operation in Oregon Township; some of them are on extensive scales. In Spanishtown one or two leads have been opened, on which machinery is being erected. At Wyandotte, Dicksburg, and in the vicinity of Forbestown, quartz operations are being prosecuted, but we do not know how extensively. We hear every day of new ledges that are being prospected in all parts of the county, many of which have changed hands at

a very high figure. Our quartz miners are very far behind those of Nevada and Amador counties, where the business has become well established."

In Grass Valley very little is doing in quartz, just at this time, in consequence of the heavy rains, which have rendered the roads so bad, that it is almost impossible to haul the quartz to the mills. Those who have mills upon their veins also have been very much inconvenienced by the unusual quantity of water which has fallen, which in some cases even gains upon the pumps. Much damage has also resulted from caving in of shafts and tunnels. The hindrance, however, is merely temporary, and the mills will soon be all once more in full clatter.

Messrs. Hubbell & Co. have recently put in operation a quartz mill, at Downieville, under most flattering auspices. The mill is on the North Fork, just above town, and runs for the present 4 stamps driven by water power. Their first crushing was from surface quartz, mostly taken from above ground. Whole lot crushed, eighty tons—yield nineteen hundred—within a fraction of $24 to the ton.

Messrs. James Beswick & Co., at Newtown, El Dorado county, have just completed a tunnel 260 feet long, and struck their lead, which, according to the Placerville American, "fairly sparkles with gold" at the point opened. The lead is supposed to be both rich and extensive, and the proprietors are taking active measures for the early erecting of machinery upon it.

Dr. J. S. Marlette has struck what appears to be a very rich vein of quartz, about one mile east of Doak's Saw Mill, at the head of the north branch of Murray Creek. The vein is about four feet wide, and has been traced for two miles. It is on a direct line with the rich veins of Angelo's and Carson's Creek. We gather the above particulars from the San Andreas Independent.

Lovely Rogers, and others, says the Mariposa Gazette of the 13th of Feb., have recently struck a very rich vein in Gentry's Gulch, about ten miles east of Coulterville, which, from all accounts, is of marvellous richness. It is from 11 to 16 inches in thickness. Fifty feet of the vein has been prospected, and every part and piece of the quartz shows gold. Mr. Rogers brought to Mariposa a small quantity of rock, one piece of which weighed thirty-five ounces, and upon being reduced yielded a trifle over $300.

Messrs. Kennedy, Heming & Co., according to the Jackson Sentinel, have a very rich vein near that place, which promises to be the richest lode in Amador county. The rock has been thoroughly assayed, and found to yield $160 to the ton. The owners have commenced operations on the claim in earnest, by sinking a shaft, and erecting a mill, which will be in complete working order in a week. There are six shares, some of which have been sold by the discoverers for $1000.

A new quartz mill is shortly to be finished upon Bear Creek, a short distance below the junction of Corbett's Creek. It will be a water mill, and can run, in ordinary seasons, six months in the year.

A very rich specimen of decomposed quartz has been found in a newly discovered vein at West Point, Calaveras county.

The newly discovered quartz ledges in the vicinity of Spanishtown, give many evidences of richness.—*Cal. Mining Journal.*

PLACER MINING SUMMARY FOR FEBRUARY.

The miners' harvest time is now at hand, and we have cheering intelligence, from every quarter, that the golden products of our hills and ravines are fast being gathered into store. The rains have been unusually abundant, and immense quantities of snow have been piled up in the mountains, as a source of our summer's supply of water. The inclemency of the season in the higher altitudes has thus far operated as a barrier against any very steady progress of mining operations there, but the bright promise of the "good time coming" keeps up the miner's hopes, and cheers his lonely hours as he sits in his snug little cabin quietly awaiting the approach of the genial spring

which is to unlock the fountains of water, so that he may once more ply his pick and shovel. Low down, and among the foot hills, where the snow king fails to fix his icy grasp, all is, even now, bustle and animation. Rich strikes and immense yields are as common as ever, and there are but few, who, with well directed energy, fail to realize a handsome return for their labor. We have collected a few of the more prominent items of "good luck," which have been reported during the past month.

In Sierra county, at Smith's Flat, nearly all are doing extraordinary well, 700, 500, 400, and 300 ounces are common results of a week's work for one company. The New York Company, three weeks since, had $40,000 ready for the mint. At Chip's Flat, Forest City, Minnesota, and Monte Christo, the miners are all doing remarkably well.

In our own county we hear of highly favorable reports, especially from San Juan and the vicinity of Nevada. Immense amounts of gold are now being taken out in the neighborhood of Selby Flat and Brush Creek. The mines of that neighborhood are very extensive and of almost fabulous richness. The Yankee Mining Co. at Chip's Flat took out on the 7th of February a five hundred pound lump, and several other smaller "nuggets." The Pacific Co., at Allegany Town, lately realized $4899 from two days' washing.

The San Andreas (Calaveras Co.,) Independent, of Jan. 31, says:

Messrs. Hill & Co., on Wallace Gulch, are now making $21 per day to the hand. This average pay has been taken out of their claim for the past ten days. Another company of five miners, working in a small gulch near by, are making one hundred dollars per week, clear of water money.

The claims in the vicinity of Central Hill are still paying as rich as ever. In the claim of Messrs. Bright and Co., they are taking out dirt in which the gold can be easily seen through every shovel full.

John Veazie & Co., mining in Five Point Gulch, this week, (six men being at work,) have averaged an ounce and a half per day to the man. This yield is from the surface dirt, never before disturbed; the bed rock is not over three feet from the surface; about eighteen inches from the bed rock is a sticky brick red earth, evidently decayed quartz; the big chunks are all found in this earth—although the lighter loam on the top also pays well. A thirty-six dollar *chispa* was found near the surface, Wednesday last, while shoveling dirt into the sluices.

Mr. David Robinson & Co., (three persons,) took from their claim, near Dog Point, fifteen ounces one day last week—only a fair average of their claim.

George Shawl & Co.'s claim is also paying its pounds per day; twenty ounces per day is a light week's working for three men. The dirt was all carted out during the past summer.—*California Mining Journal.*

SULPHURETS—THEIR NATURE AND TREATMENT.

It is a mistaken idea, and one which has too generally obtained, that practical gold mining needs but little or no study beyond that necessary for the mere mechanical extraction of the ore from its veins, and the most economical method of reducing the same, preparatory to its passage over the blankets, or through some approved apparatus for amalgamation. In no part of the world is this idea more general than in California. This fact arises, no doubt, from the circumstance that here are found great numbers of veins exceedingly rich in the precious metal, where but very little attention is needed to realize almost fabulous returns. Here, men in their anxious haste to get rich, cannot stop to study or closely examine, but pass on from one locality to another, in the eager search for a "great strike," where they may take out their "pile" in a few months, or years at most, and then go elsewhere to enjoy their gains. While a scanty few are successful in such practice, the great mass thus go on from one to another for months and years, until they become perhaps discouraged and disgusted with the very idea of mining. It was owing to this

latter characteristic of our miners that quartz mining was so well nigh abandoned a few years since in this State—it is to the wiser policy of patient and intelligent application—of study and close examination, that we now behold this interest fast taking a leading position in our industrial pursuits. It is to be hoped that the period is not far distant when a full and thorough investigation of the properties and condition of our mineral veins shall be made by men of energy, and of acquirements and experience, which shall fully qualify them for such a task.

Each class of mineral veins is a study of itself. The study of iron alone will occupy a lifetime; so also of lead, copper, silver or gold. The masses of operators, as we have elsewhere said, cannot go into the intricacies of such studies, but with a very little attention they may be enabled to make an application of general principles to particular localities. It is a proper exposition of these principles and their application to some of our most important veins that we now need. This is a work indeed, the *onus* of which should fall upon the government. Of this matter we may speak more at length at another time. We set out to give an account of the nature and treatment of sulphurets, and will now return again to our subject.

The sulphuret of iron or iron pyrites, although one of the most common and widely diffused minerals on the globe, is nevertheless one of the least understood. Many of its phenomena are very curious and interesting, notwithstanding the little that is accurately known of them. Its very combination, even, is a matter of doubt. Although it is well known that it consists of sulphur and iron, still the peculiar state in which they are combined, and the conditon of its separate ingredients during the period of its combination, are matters which have never yet been explained. It has not yet been shown whether these pyrites consist of an aggregation of sulphur and iron, or a chemical compound of the two.

Some veins abound with bright glistening pyrites of a cubical form; some with those of a dull black color; and others still with cellular cavities partially filled with soft and almost impalpable powder, varying from a light to a dark brown, which is the resultant of a spontaneous decomposition of the pyrites, and is called sulphate of iron. Some of the cavities of the cellular or "honey comb" quartz contain the pure flour of sulphur unmixed with any thing save, perhaps, a trace of gold. The iron has entirely disappeared, through the unbroken and compact mass of quartz, without leaving even a *stain* to mark its former habitation, or its exit. How it has thus disappeared none have yet told us. That these cavities once contained crystals of sulphuret of iron there can be no doubt. What mystic power has formed them, filled them with hard and perfect crystals, and subsequently changed their condition and removed a large portion of their component parts without in the least disturbing their nicely formed and delicate angles, or any portion of the surrounding and refractory silica, has never yet been satisfactorily ascertained. There can be little doubt, however, that galvanism, the great supposed agency of Nature in her wondrous and invisible laboratory, has acted an important part in conducting this curious process.

It has long been known that in many great gold bearing veins, these sulphurets, although occupying but a very small portion of the mass of the ore, (say from 3 to 8 per cent. only,) nevertheless contain a large proportion, and in many cases a large majority, of the gold contained in the entire mass. It is furthermore well known that the gold is more readily collected from the quartz itself than from the sulphurets, and that the great discrepancy between the assay and the practical yield, is mainly owing to the refractory nature of the sulphurets in yielding up their portion of the gold. Hence it becomes absolutely necessary that the *sulphurets* should become a subject of careful and continuous study.

Careful experiments have shown that a process suited to one class of sulphurets will not answer so well for another. This fact was sufficiently proved

by the Russian experiments already alluded to, in the following manner, and with the annexed results.

1st. A given quantity of argentiferous pyrites, not containing gold, and in which the actual quantity of silver was determined by assay, was taken, and to them were added a given quantity of powder of gold, chemically prepared. The mixture was then roasted upon a tile, in a muffle. This experiment was repeated several times, with the following results, viz: 14, 16, 20, 22, 26, 37, & 40 per cent less gold was obtained than was originally put into the mass!

2d. To demonstrate that the presence of *sulphur* was not the cause of the loss of gold, a given quantity of powder of gold was mixed with an ore of iron, containing the oxide of iron and water and carbonic acid, but in which was neither gold or sulphur. The mixture was roasted as above, and the results showed a loss of from 7 to 23 per cent of the gold dust.

3rd. Experiments with different lots of pyrites mixed with the same sort of iron ore as above, into which given quantities of gold were thrown, showed losses varying from 4 to 24 per cent.

4th. Gold mixed with ordinary volcanic sulphur, and treated precisely as above, lost only *four per cent.* probably because the powder of gold was so suddenly melted into an agglomerated mass, that there was no opportunity for it to pass off in its original form with the vapors of the sulphur.

The unavoidable conclusion from these experiments is, that gold, when mixed with substances susceptible of volatilization by the action of heat, volatilizes with them, *in proportions commensurate with the peculiar condition of the bases with which it is mixed.* The officer in his Report to the government also states that the more heat employed in the process of roasting, the greater was the loss of gold. It appears from the report to be a very marked fact that the loss varied very materially with the different qualities and conditions of the ore.

There is one circumstance noted by M. Bassingault, who, among others, has repeated these experiments, which, if correct, is of considerable importance. He found that by *the addition of common salt* to the mass during the roasting process, the result showed much less loss than *without that addition!* —*California Mining Journal.*

THE QUARTZ MINES OF GRASS VALLEY.

The prospects for the future of this branch of mining in our favored section, are most cheering; and although trouble and failure may yet await some, we confidently believe that the darkest days are passed, and that success will attend a large majority of those now engaged in the business. The developments of the past year have been most satisfactory, and have added several rich leads to our already extensive catalogue. Some, which had proved rich in the "croppings," but had become too poor to admit of their being worked, have been again tested at a greater depth with satisfactory results.

The reduction of the value of labor has been attended with most beneficial results, by creating an increased demand, and by stimulating experienced miners of enterprise, to prospect for themselves, rather than to work at reduced wages. Intelligent miners are beginning to view this redution of labor with more favor; they argue that if they can be employed as they now can, the year round at three dollars a day, they will be better off at the end of the year, than if they had been working for one third of the time at six dollars, as heretofore. At three dollars a day, they can *save* more from their wages than their entire wages would amount to elsewhere, while California presents a wide field for their own enterprise. Quartz, more than any other branch of mining, is calculated to give a stability to our population, of which no better evidence in California can be found than in Grass Valley, where the miners are drawing round them their families with the comforts of home, and they begin to feel "at home." The extensive School-house recently erected, and which would do credit to the most flourishing village in the States, is an

evidence of the requirements of our community. Scarcely a steamer arrives that does not bring one or more to cheer the hitherto disconsolate hearths of our industrious miners. All we want to induce immigration is *constant employment*, with cheap living, which will enable men to work with satisfaction, at the reduced rates of labor, and induce them to settle down, rather than to wander over the State in search of "their pile."

All the great improvements in machinery have been sent to the foundry, to be recast into stamps, and the present mode of reducing the ore and saving the gold does not differ essentially from that practised at least two centuries back. The cry is no longer that "the rock contains gold, but we cannot save it," but "give me the ore that contains gold, and I will get it out." Though unquestionably *some* of the ore contains sulphurets, rich in gold, which is not at present obtained, for the want of some cheap and expeditious method of extracting it; yet the tailings containing those sulphuret, are put aside for future operation.

The great reduction in the cost of machinery, added to the necessity in many instances of employing steam power to drain the mines, is inducing many of our miners to erect small mills to reduce their own ore, by which they save the expense of hauling; quite an item, as well as the charge of $6 a ton for crushing, while the additional expense incurred is not over $15 a day. Thus, the mine which would produce 5 tons only of ore per day, would save in crushing at least $4 per ton. We append a list of mills and pumps in operation, with those contemplated.

Allison Ranch, 8 stamps, steam power.
Lee's, 10 stamps, steam and water.
Mount Hope, 16 stamps, steam power.
French Mill, 9 stamps, steam power.
Lady Franklin, 8 stamps, steam power.
Helvetia & Lafayette, 9 stamps, to be increased to 18—steam.
Larimer's, 12 stamps, water power.
Kram's, 4 stamps, water power.
Grass Valley, 9 stamps, steam power.
Gold Hill, 21 stamps, steam power.
Orleans, 16 stamps, steam power.
Wisconsin, steam pump in operation, batin progress of erection.
Sebastapol, steam pump, battery to be added.
Consolidated Co., steam pump, battery to be added
Hartery, steam pump, battery to be added.
Rush on Wiemer Hill, steam pump.
Cincinnati Hill, steam pump.
Gold Hill, steam pump.
Osborn Hill, steam pump, battery to be added.
St. John's Saw-mill, battery to be added.
Primrose Valley, pump, with mill erecting.
Badger Hill, pump and mill to be erected.
Rattlesnake, pump and mill to be erected.

Then there is the Mount George mill with 12 stamps, at present idle, and a steam pump to be erected by Messrs. Woodworth & Co., Alta Hill, No, 2. adjoining the famous Alta Hill lead.

JOURNAL OF COPPER MINING OPERATIONS.

NOVEL TREATMENT OF POOR COPPER ORES.

In our last CHRONICLE, we alluded to a process which has been successfully practiced in Norway, for the reduction of poor ores of copper; at the same time we mentioned that operations of nearly the same nature were being conducted at Twista, in Germany. It appears, however, that at the latter place they use scrap iron and acids for the reduction of the mineral to metal; and consequently, some outlay is required in order to render the ore available. In the Norwegian process, however, according to the subjoined account, only water and fuel is required, and a sufficient quantity of iron pyrites, or mundicy ores. This process was first practically brought into operation by Bergmester Sinding, and has, both at the Foldal and Eker Works, been found to answer successfully. We are not in possession of the minutiæ of the operations, but we give the results and some brief details furnished by one who has practically superintended and carried out the process:—

Low quality of copper ore no matter of what kind, which cannot be reduced any other way, may be rendered productive at a proportionably small expense, with little fuel, and no very large plant, provided a certain quantity of iron pyrites is to be obtained at a low price. If the ores to be treated already contain mundic, the less iron pyrites is required; if quite free from sulphur, the more is necessary; but for a portion of the quantity sulphuric acid may be substituted, if that can be got at sufficiently cheap rate; but every kind of iron pyrites containing copper will therefore be available, to much greater advantage, and a large quantity of sulphur likewise obtained in addition. In this process the iron pyrites serve for two objects—1. To bring the ores containing copper into a state soluble by water. 2. To produce sulphuric acid gas, which is used to extract the copper from the solution in water. When, however, other ores containing copper are to be had, it is not necessary that the iron pyrites should contain copper, but it is all the better when it does. At Foldal there is a large quantity of iron pyrites containing copper, both calcined and uncalcined, which would not pay for smelting, the best having been previously picked out. The works were abandoned for several years, on account of their not meeting the cost; at this time by the aid of the present process, they are again in operation, and paying a considerable profit.

The original amount of shares was $40, they can now be scarcely had for $1300. These large masses of copper pyrites, although they only contained metal of a very low percentage, had, by laying exposed for many years, formed combinations of copper, which were soluble in water. By, therefore, leading a stream of water through it, a large quantity of copper would be taken up, of about one-fifth per cent. This water, holding copper, is profitably returned at the cost of $12 per skpd (320 lbs.) of copper. The water might, if much poorer, say 1-20th per cent., pay nearly as well, as the expense of rendering it profitable would scarcely be more. To produce 100 skpd of copper at Foldal, 500 barrels of pyrites are required, each weighing from 600 to 700 lbs. 120 cubic fathoms of wood, with ten laborers; two months. Of course, a large plant with abundant supplies of low copper ores, would enable the operations to be extended in proportion. The iron pyrites there cost about 36 skillings per barrel, and a cubic fathom of wood may be had for $2 12. Coal is much more desirable for fuel, but wood is used there on account of the works being inland, and its great abundance. In old mines, where large burrows of low-quality copper ores have accumulated, all the iron will here be saved, and a much purer copper is obtained than that now procured by the use of iron. Mines of iron pyrites, containing copper of 1 per cent. and under,

will pay well, if the expense of mining is not too great. Iron pyrites, with about 1 per cent., can be obtained at the rate of $1 per barrel; the cost of reducing is only 48 skillings; and one per cent. of copper in a barrel of iron pyrites represents a gross value of $2.

It must be borne in mind that, in giving the above details, we are not furnishing calculations, but the absolute data of the expenses that have been incurred in carrying out the process to a successful issue.

The works are at a considerable distance inland, subject to many disadvantages, so that, probably, under more favorable circumstances, operations might be carried out on a more reasonable scale. It will be remarked that coal is considered a cheaper and more desirable fuel than wood, but owing to the carriage from a distant seaport, through a mountainous country, its use is not available there. Judging from the cost of reduction in Norway, which is the scale here given, it would appear that in a more favorable locality, the process could be conducted more advantageously.

LAKE SUPERIOR MINING REGION.

From the *L. S. Miner*, just received, we extract the following:

The *Derby* mine is situated about 4½ miles west of Norwich. The location contains in all 320 acres. Work was commenced in 1852, and operations were discontinued in 1855. In the mean time they had sunk two shafts to the depth of 80 and 60 feet—made one drift in course of vein 250 feet deep, and one drift from the deep shaft. Of surface improvements they have cleared about 15 acres of land, 4 good dwellings for miners, 1 smith shop, 1 barn, and 1 store-house. They took from their openings 1,220 pounds of copper.

The next mine as you come east along the range is the *Clinton*. Here work was done in 1853 and 1854. They have 320 acres of land, of which 8 acres are cleared. They have two houses. One shallow shaft comprises all the mine workings.

The *Cascade* comes next to the Clinton. Here is one dwelling and a very small clearing. This location possesses the advantage of a valuable water power, which could be made available for a trifling expense, and is abundant for stamping and sawing. Some exploring has been done, but no regular mine work.

Next comes the *Sharon* mine. The tract comprises 160 acres of land. The surface improvements are 15 acres cleared, 2 good dwellings, 1 store-house, 1 barn, and 1 smith shop. The underground works consist of 2 shafts on No. 1 vein, one of which is sunk to the depth of 80 feet, with levels driven east and west from the bottom 25 and 40 feet. Another shaft was sunk on No. 2 vein 110 feet. They commenced work in 1852, and suspended in 1855.

The *Clifton* mine next in order. It is situated about 1¾ miles west of the Norwich. Work was done here in 1853–4–5. The tract embraces 320 acres, of which 12 are cleared. Of buildings, they have two dwellings, one barn, one smith shop, and one store-house. The mine workings consist of an adit driven 300 feet across the hill, and an air shaft in the country sunk to the adit about 20 feet. A shaft is also sunk on a vein about 15 feet.

The *Pittsburgh* is ¾ of a mile from Norwich. They have 480 acres, of which 18 are cleared. They have two dwellings, one store-house, one smith shop, and a barn. They have opened, we believe, on three veins. On the first a shaft is sunk 60 feet. On the second is a shaft 80 feet deep and a cross-cut south from the bottom 40 feet. On the third vein a shaft is sunk 15 feet. They were worked in 1852–4–5.

The *Hudson* mine has a fine tract near to the Norwich—a forty acre lot only intervening between the locations. They have 320 acres of land with a small clearing, upon which are two dwellings. They worked in 1853–4–5. The mine works are on two regular and well defined veins which are well

explored.—On the first of these a shaft was sunk 60 feet. On the second a second shaft was sunk 75 feet, and drifting west on course of vein was done 36 feet.

The *Ohio Trap Rock* mine is one of the oldest locations in the Ontonagon District. Its history is too well known to require a description here. The tract is very large, comprising 2,000 acres of land, and extending entirely across the range with the exception of the property of the Norwich and Windsor mines on the south side, and also extending along the range for a distance of two miles. They have a large amount of surface improvement, but all their machinery and structures, except the church, are in bad repair. Some 120 acres of land are cleared, with a large amount under cultivation. Works in the mine were entirely suspended in May, 1856; their latest attempts being in the shaft which was intended to cut the Windsor vein.

A great deal of underground work has been done upon the several veins upon this location. The largest opening is on the pressure vein. Two shafts are sunk, and four levels driven. The Indian diggings vein is also quite well opened, and important underground works have been made on the Park vein.

Three mines have been opened to really a considerable extent upon the Trap Rock location, but they have failed to satisfy the expectations of stockholders.

The Norwich is the only mine at present worked to any great extent on the west side of the Ontonagon river. Except at that mine and the Forest and Trap Rock, but little more than exploration has been done in this part of our district. The difficulty of getting supplies to the mines, as well as want of knowledge of the country, arising from its inaccessibility, seems to have prevented adventurers from investing very largely there. The mineral indications are certainly sufficient to warrant a far greater outlay, and in truth, we consider them abundant to make this part of our district the theatre of extensive mining operations. The above named mines are situated well for mining. With the exception of the Trap Rock, they all have the face of an escarped bluff to work in, which gives them a fine opportunity to approach the veins and get drainage by an adit. The Ontonagon River runs within a convenient distance of their mine works, affording abundant water for stamping. The commencement already made on the surface by clearing and building, and in the mines by various openings, will prove very valuable to future adventurers, though these improvements may seem small. And small though they are, they represent an amount of labor and cost not to be compared with those of similar improvements made in settlements where the necessaries of life can easily be obtained. Works on these locations can be resumed at once, whenever it is desirable to push them on. The improved lands have been of some benefit to the mines worked, and will be very valuable to the new adventurer.

At present the Norwich stands alone in vigorous and earnest mining on the west side. All others have temporarily fallen back before the storm of difficulties which must be encountered by those who undertake to operate so far from the accustomed paths of commerce and settlement. As she has thus far maintained herself quite bravely, we think a somewhat elaborate account of the mine operation and present condition will be interesting.

In 1850 mining operations really commenced on this location. It was then one of the mines of the American Mining Company. A little work had been done before—a small log hut was made, and a shaft sunk some 60 feet, but in the year named they determined to open a mine. The supplies had to be packed on the back of men, from the old Mendenhall Landing, some twelve miles from the mine, which was effected by great labor and expense. The outcrop of the vein is on the scraped side of the bluff, which affords no opportunity for placing even a windlass, without blasting away a place to set it. A short adit was therefore driven to the vein from an accessible point below the outcrop, and a chamber

hollowed out large enough to operate a horse whim, and a shaft was sunk from that point. An adit was afterwards driven from a lower level to the same shaft, which was at once made the channel through which all the stuff taken out of the mine was hauled. They sunk below an outcrop of copper, which was afterwards found to be part of a wide course of copper-bearing rock, inclining to the west at an angle of about 45°. As soon as they had reached it in the driving from the adit level, a great deal of rich ground was exposed, from which they took in one year about 175 tons of copper.

The total copper taken from the mine up to the present time, is about 450 tons, which has been of high purity, and a considerable part has been mass copper—probably a little less than one-third was stamp work. The product of the mine for the last two years, has not equalled that of the preceding year. Without noticing for the present how far this was occasioned by the lack of supplies, or by the destruction by fire of their stamp mill, we think an intimate acquaintance with their underground operations, will furnish reasons for this falling off. In this, as in all other mines, the distribution of copper is very unequal, though its deposit seems to be made in accordance with certain laws which the intelligent miner will soon discover. There seems to be two courses of copper-bearing rock in this mine, the most important of which is the one mentioned above as first appearing at the surface, over the shaft, and dipping to the westward. When this course was struck by the adit level, they had exposed a splendid back of rich ground, 140 feet in height, and perhaps near two hundred feet long. In stopping this away they were enabled to get out the copper quite rapidly, while their financial condition was such that the openings could not be pushed forward as fast as was desirable; for the lower they sunk, the farther they were compelled to drive before reaching this productive belt or course of copper. Within a few months, however, they have reached it in the fourth level, and have taken considerable copper from it.

It is probable, that when the fifth level shall be extended west far enough to reach it, they will have exposed another large amount of stoping ground, in the same course of copper rock. Had their openings been so extended as to keep this belt exposed, the product of the mine might have been considerably greater, though this is one of the *probabilities* connected with mining. About 500 feet east of the main shaft, there is a remarkable cross course which shows on the surface by a deep indentation of the bluff. Its width is 8 or 10 feet, and it is filled with very easy rock. The adit level is driven some 200 feet east of the shaft, and is therefore within about 300 feet of the crossing. Now the surface indications, contour and regularity of the bluff, &c., are such as to point out the ground to the east of this crossing as a promising field for the miner. Should the courses of copper make the same dips to the westward, as in the western part of the mine, they will be reached in a much shorter distance in the lower levels.

Last week we examined somewhat carefully the new underground workings of the mine. There are now in sight five important masses, all of which are west of the main shaft from 200 to 400 feet, and all within the course above mentioned. In size, they do not, of course, compare with the large masses of the Minnesota mine. But one in the back of the fourth level was estimated to be of some 8 tons weight, and required to be cut into at least four pieces. Another from the sole of the level, and its size was of course unknown. Some two tons had been taken away from it. Another in the 4th level was too large for handling and they were cutting it up. One part of the cut showed eleven inches thickness of bright copper. Other places were in sight showing copper, which Mr. Davis assured us, repaid well for taking down the vein.

In the eastern openings, the vein is not showing much that is valuable. At the bottom of the shaft it has become quite thin, but there is abundant evidence of its continued depth.

A vein of epidote and quartz is met with south of the vein now worked, which presents many interesting features. It is from two to four feet in width.

It lies much more flat than the principal vein. At the mouth of the short adit, it is 105 feet from that vein; while at the main adit level, it is only 45 feet from the same—thus drawing nearer by 60 feet in a vertical distance of 140 feet. It is traceable for a great distance on the surface beyond the bounds of the Norwich location both east and west, is quite large wherever it appears, and in many places shows copper. It is well worth looking up, and could probably be struck by a short cross-cut from the bottom of the main shaft.

Some 200 feet south of this is a remarkable clay vein, which is thought to be the same as that upon which the Windsor is now sinking at their new works. They drove a small drift east and west but found no copper.

The fiscal year of the Norwich Company has heretofore terminated on the first of April. They have now adopted the plan of closing up to January 1. During the nine months intervening they have raised some 67 tons of copper. But as their stamp works were destroyed by fire, they have only the stamp work available for about three months of that time. Had the mill been running for the whole time, the product of the nine months would have probably been increased by about 25 tons—making it 92 instead of 67 tons. They have worked during that time an average of about 64 miners.

The erection of a new stamp mill has subjected them to an extraordinary expense for construction, amounting to about $8,500; and the prosecution of the new western adit has also been quite a tax. Deducting these items, the amount of copper raised, during the nine months,—including the probable amount of stamp work raised, less the expense of manufacturing it,—would about cover the expenses. About one-third of their copper has been stamp work. The stuff has accumulated greatly since the burning of the old mill, but the new one is industriously engaged in manufacturing it.

Their stamp mill is in very efficient and satisfactory operation. The engine and much of the machinery of the old mill is now repaired and replaced in the new. During the fire by which the old mill was consumed, they succeeded in keeping the important parts of the engine from heating so as not to spring or distort them, and with the addition of a few pieces, the old machine is enabled to perform excellent duty. There are sixteen heads of stamps. These are lifted by a peculiar cam, the operation of which is very satisfactory. The percussion table is in use for washing. The mill is situated within a few rods of the West branch of the Ontonagon river, from which the supply of water is taken. The facilities for getting the rock to the mill are perfect. It is trammed from the mines to the kiln, and, after burning, it is thence taken by railway and dumped into the hoppers of the stamp house. Their fine copper has certainly been well cleaned, as their total product for last year yielded, at the Detroit smelting works, about 74 1-2 per cent. of ingot copper.

The new western adit, of which we have published several notices, has been driven to the probable place of the vein, but has not as yet disclosed all which was expected from it. But there can be no doubt of its future value, if the western part of the ground is found to carry copper enough to pay for working. It is a fine and capacious gallery, large enough to admit of pumping and hoisting machinery, besides doing the ordinary business of such an opening.

As the main shaft was sunk to a considerable depth, a necessity arose for hoisting power greater than that afforded by a horse whim. As the outcrop of the vein is in the face of a scarfed bluff, there is no possibility of placing an engine on the surface at that level. An engine was therefore placed at the foot of the bluff, 140 feet vertically below the mouth of the short adit—a rope was run up the hill on polly stands—thence for 100 feet through the adit, and down the shafts. The plan operates admirably. The engine has a twelve inch cylinder with two feet stroke, and locomotive boiler, so placed that the under is exposed in the first instance to the fire, which returns through the tubes—thus giving an extraordinary amount of heating surface. The effect of

this arrangement is great economy of fuel. The machine does excellent duty on a little more than a cord of bad cedar wood per day.

The new buildings erected are, the stamp mill and saw mill, to replace the old ones burnt last spring—and a blacksmith shop. A fine boarding house, for agent, clerk, &c., was erected about a year and a half ago, of which we have published no account.

JOURNAL OF SILVER AND LEAD MINING OPERATIONS.

SONORA EXPLORING AND MINING CO.—FIRST ANNUAL REPORT.

The object for which the Sonora Exploring and Mining Company was formed is one of great interest at the present time. The United States had spent Ten Millions of Dollars in the purchase of a strip of country taken from Sonora, in Mexico. This strip, situated between the immensely valuable gold-bearing State of California and the equally valuable silver-producing States of Mexico, might, from analogy of geographical position and geological formation, be supposed to contain valuable minerals, which needed only enterprise and labor to develop. Convinced of this fact, as well from personal knowledge as from the testimony of others, the projectors of this company set out a year ago with the determination of exploring this region, then under the absolute dominion of the tribe of Apache Indians, who had more than a hundred years ago destroyed the early settlements of the Spanish, and driven them to the more southern provinces. To do this with safety, it was necessary to send an armed party, of sufficient strength to protect itself under any contingency, and to maintain its position against any force of Indians that might be expected to attack it. When the work of exploration was brought to a successful issue, the same party were to hold possession and protect the miners and laborers that were needed to develop the property acquired.

History of the Company.—Such was the object of the projectors of this important enterprise. On the 24th of March, 1856, the company was formally organized, articles of association drawn up, and officers elected. Col. Charles D. Poston, a gentleman of experience in this territory, was selected as the Military Commandant of the exploring party and Agent of the company in Sonora. He was ntrusted with the important duty of forming the party, procuring the necessary scientific aids, and the selection of mines and lands. In his letter of instruction he was directed to explore from the Rio Grande to the Colorado, and examine the mineral deposits of this region; to seek for abandoned mines, and to select the best location for the permanent operations of the company, that his explorations and opportunities of information might dictate. In all cases to prefer silver to gold, and to locate as near the navigable waters of the Pacific as might be consistent with the possession of the best and most promising property. In compliance with these instructions, Mr. Poston proceeded to San Antonio, in Texas, and there outfitted his party. Some delay was experienced at San Antonio, in consequence of the non-arrival of the arms and military equipments sent from Cincinnati for the use of the party. On the reception of these, Mr. Poston and his party set out on their expedition, and arrived safely at the Rio Grande. Here the party rested to recruit the animals and refresh the men. While resting here, offers of mines near

the Rio Grande were entertained and forwarded to the Directory; these were duly received and considered. They were not accepted in consequence of higher anticipations at the west. Leaving the Rio Grande, the party visited the copper mines near that river, and forwarded their report on them. They next followed Grey's Route as far as La Puerta, which they pronounce to be the best pass for railroad purposes, or for emigration, in that whole chain. Thus far the incidents of the expedition had been attended with but little serious danger. At La Puerta, however, they encountered a war party of fifty Coyotero Apaches, returning from a foray into Mexico; but prompt and decisive action on the part of the commandant deterred the Indians from an attack that was doubtless premeditated. The energy and decision displayed by their agent in this matter shows the selection of the company to have been well made. Passing on to the west, by Park's route, they found considerable obstructions; but having surmounted all, arrived safely at Tucson in the latter part of August. Here they were joined by Mr. Ehrenberg, a geologist of great experience in this section, and whose accession to the company was considered very desirable. The head-quarters of the company were established at Tubac, which, under Mexican rule, was the centre of operations in this region, and to our company was a very desirable location, from its pure air, good water, and abundance of grass and wood. The party are now safely established there, and have permanent buildings and secure defences in case of attack. The danger of this, however, has been greatly lessened by the arrival of Major Stein and his command of United States dragoons, established at Calabazas, within fifteen miles of Tubac. This fortunate circumstance relieves our party at once of the care and trouble of Indian fights, and leaves them free to engage in their mining pursuits with perfect safety.

The attention of the party was first directed to the Santa Rita Mountains, where indications of ore were found. These, being traced up, led to the discovery and occupation of the old works known by tradition as the Salero and Ojero mines, and to the discovery of twenty-two new veins of silver ore in the same mountains; all of which were at once occupied, and measures taken to give the company a legal title to the same. A permanent camp was established, and miners set immediately at work cleaning out the old shafts and opening new ones. According to tradition, the last attempt to work these mines was thirty-five years ago, when the whole party were killed by the Apaches. Their ruined huts still remain, and attest the fact of their occupation. The mines were said to yield ten per cent. of pure silver. The Salero (salt-cellar) mine took its name from the incident which gave rise to its occupation. When the Bishop of Tumacacori, a mission three miles south of Tubac, came to take charge of his diocese, he complained much of the hardships he had to undergo in this northern province compared with the luscious fare and rich viands of his former residence at the south, and one day at table said he had not even a salt-cellar to hold his salt. One of the zealous parishioners said, "Wait until next Sunday and I will bring you one." He immediately took to the mountains, and fashioned a rude salero from the silver mine in the Santa Rita Mountains, which in due time graced the Bishop's table, and gave its name to the mine. The Ojero owes its name to blue spots in the ore, resembling the blue under the eyelid. One of the new veins upon which work has been commenced contains lead with silver, and is said to be rich. In consequence of the want of suitable chemicals, no accurate assays had been made; but the blow-pipe tests of the scientific gentlemen, who accompanied the expedition, show that these ores will well pay the trouble of working them.

The fine old ruins of the mission of Tumacacori show this to have been an important point with the Spanish Jesuits who first opened these mines. The company immediately set to work building a muffle oven, and it is now in blast and works to their entire satisfaction. From the small amount of rubbish found on the outside of the mine the party were led to believe that the shaft had not been driven to any great depth. Advices as late as the first of

January, however, state that the miners had reached a depth of sixty feet, and were not yet to the bottom. The vein held good and regular. We are, therefore, led to infer that the ores taken out were rich enough to warrant transportation, and were nearly all taken away from the mine for the purpose of smelting, in which case the propriety of going to the bottom would be all the more evident.

Dispatches dated the first of January have been received from the agent of the company, announcing the gratifying and important fact that he had concluded the purchase of the Arivaca Ranche from the Mexican owners. This ranche is situated twenty miles west of Tubac, and contains four leagues (seventeen thousand acres) of land, susceptible of cultivation, and includes within its boundaries twenty-five well known silver mines that were worked by the Spaniards, and probably many more unopened and undiscovered. Copies of the title papers, vesting the fee simple and absolute in the President of this company and his successors in office, in trust for the stockholders, for ever, duly acknowledged and recorded, are now on file in the office of the company. The landmarks of this ranche are testified, by competent legal officers, to be the same that they were in 1802, and possession and occupancy was delivered immediately; so that the Sonora Exploring and Mining Company now stand sole owners and occupants of the famous old mining ranche of Arivaca, or, as the Mexican records give its name, "La Aribac." Its mineral resources will be immediately developed, and the stockholders may entertain a reasonable expectation of a remuneration for the expenses of the explorations and purchase.

Value of the Mines.—It is almost impossible to give an adequate idea of the value of the mines already acquired by this Company, because they are as yet undeveloped, and their richness unknown. It is a conceded fact, however, that the characteristics of the mines of Southern Mexico, which have given the nobility of that country their immense landed estates, were rather the abundance than the richness of their ores. That in many instances these mines were worked to a depth of several thousand feet, and still repaid their owners with immense fortunes every year. Ward states that Zambrano paid, as his tax of one-fifth the proceeds of his mine, $11,000,000. The mine of Arevalo, in 1811, yielded in seven weeks $200,000 from one level called El Divino Pastor. The Biscaina vein, which, in 1726, had produced $4,341,600, and was subsequently abandoned on account of water, was re-opened in 1762, and in twelve succeeding years produced $6,000,000. The mines discovered by the Indian brothers Arauco, in the district of Morelos, in 1826, produced in two months $270,000. In 1825 the owner of the mine of Nuesta Sonora de Guadaloupe refused $1,000,000 for the privilege of working it *three* years.

Humboldt estimated the whole produce of the Mexican mines in 1803, at $1,767,952,000.

The northern mines are conceded to be richer in the quality of their ores, and to be nearer the surface. Indeed the veins now owned by this Company all outcrop on the surface, and can be distinctly traced along the soil. The proceeds of the Stevenson mine near the Rio Grande, at the farthest possible spot from navigation, worked by a Mexican lessee, without enterprise, capital, skill, or even a sufficient supply of hands, the ores of which yield but 2½ per cent. of pure silver, and have to be transported twelve miles on mule-back to the smelting Hacienda, are stated to be now over twelve thousand dollars per annum. The officers of your Company therefore believe that they make a low estimate when they state that each vein of silver now in your possession, when worked with skill and energy, will yield the Company a nett profit of at least ten thousand dollars per annum. The annual results may then be put down as follows:

Annual Produce.

Salero and Ojero mines at $10,000 each	$ 20,000
22 new veins in Santa Rita mountains	220,000
25 mines at La Aribac	250,000
Total annual product	$490,000

And this estimate is irrespective of any new veins that may be discovered and opened and of the agricultural value of the ranche, which, in that section, must be very great. That these views are borne out by the agent of the Company and the scientific gentlemen on the expedition, you will readily perceive from the following extracts from his letter of January 1, in which, after announcing the purchase of the Arivaca Ranche, he states, "This is a great acquisition, of value beyond computation or present imagination, because its resources are entirely undeveloped and unknown. The boundaries include four leagues, and inside of these boundaries are known to exist twenty-five or thirty silver mines which were worked by the Spaniards, and we may reasonably conclude many more different and distinct mines may be found on the same place unopened and undiscovered. The tract contains more mines than any other body of land in the territory, of the same size, and perhaps in the world; and is well known to Maj. Emory, Lt. Michler, Col. Gray and all the military and scientific men who have visited this country. I would not give it for a German dukedom, because it is intrinsically and really worth more, and will become more and more valuable as developments and discoveries are made, for years."

Such is the opinion of your agent, borne out by that of practical men who have been in person on this estate. The officers would, therefore, congratulate the Company on its fortunate acquisition, and express their belief that the developments of the future will warrant their present convictions. But, to do this, means must at once be forwarded to place these mines in a state of rapid and permanent development. The appliances of an assay office and dies and machinery for coinage, should at once be sent. A stock of goods to be employed, as stores for the miners, and to supply the wants of the surrounding country, should be forwarded without delay, and such other measures taken as will place the immensely valuable estate of this Company in a stage of rapid and profitable development.

QUARRIES AND CLAYS.

BEAUTIFUL SPECIMENS OF MISSOURI MARBLE.

A gentleman direct from St. Louis, left at our office this morning several specimens of Missouri Marble, from the Ozark Marble Quarry, eighty-seven miles from St. Louis, and five miles from the celebrated Iron Mountain, located on the line of the St. Louis and Iron Mountain Railroad. There are eleven specimens, each of which differ in appearance—are actually a different quality of marble—yet all from the same quarry. In examining them, so far as our judgment goes, which of course is dependent upon external appearance, we think the marble not only beautiful and susceptible of high finish, but durable, and equal even to the Italian. The grain is remarkably fine, exquisitely variegated, having a Mosaic configuration. This marble is admirably suited for mantels and other ornamental work, as also for building purposes. Mr. Gaddess, a well known marble worker of Baltimore, pronounces it highly superior—more valuable than that imported from Italy. The mantels and other fine work of the Capitol Extension buildings at Washington are to be of this marble. Some of them are already finished, and the residue being completed in St. Louis. The quarry from which the specimens here noticed

were taken, was opened some twelve months ago. It is of vast dimensions, being over three miles in length, and almost inexhaustible. Besides this, there are several others of a similar character in Southeastern Missouri, all of which are destined to be worked when made accessible by railroads, thus rendering marble of a desirable character not only abundant, but cheap, in all parts of our country. The period probably is not distant when buildings in Baltimore, and other Atlantic cities, will be found constructed of this beautiful material, which, as we are informed, can be placed here at a very moderate price. The specimens thus noticed are now in our counting-room, and can be seen by those feeling themselves interested in such matters.—*Baltimore Patriot.*

MISCELLANIES.

LARGE YIELD OF IRON FROM A LEHIGH STACK.

We learn, says the Easton *Sentinel* of the 12th ult. from one of the stockholders in the Thomas Iron Company, whose furnaces are on the Lehigh, at Hakendaqua, Lehigh county, that they turned out of a single stack, week before last, *two hundred and sixty-seven tons* of pig metal. This we believe is the largest yield ever obtained from a single furnace. Lehigh Valley against the world for making iron.

NEW YORK METAL MARKET.—Wednesday, March 18, 1857.

Iron.—Scotch pig is fairly active, and is firm at the advance; we note further sales of 300 tons in lots from yard, at $31 50, 6 months, with more to be had, even to arrive at any concession from this price, while some importers are firmly demanding $32; job lots sell at a slight advance on these rates. American has been in active demand, and the Pennsylvania manufacturers are said to have contracted largely, for future delivery, at $27–$28. Common and Refined English Bars are still in meagre supply: the former are very firm at $58–$60, to arrive, and the latter at $67 50–$70; small parcels to the jobbing trade sell at a slight advance on these rates.

Copper.—New Sheathing and Yellow Metal are steady, and in fair request, at 34–35c., in suits, for the former, and 28c., 6 mos., for the latter. Refined Ingot is quiet but steady at 28–28½c., 4 mos. Old Sheathing is fairly inquired for at 26–26½c., cash.

Tin.—Block Tin is devoid of animation, but prices are sustained. Banca is firm at 36½c., cash, by the invoice; job lots command 37–37½c.; of straits some 100 slabs have been sold at 35¾c., cash; small lots from store sell at 36½–37c., 6 mos. Plates are rather quiet, but prices remain firm.

Lead.—We notice additional sales of 50 tons German, to arrive, and 40 tons do. on the spot, both at $6 37½.

Nails.—Cut are in demand, at unchanged prices; sales at 4c., 6 months. German Wrought, 7–7½.

Spelter.—The demand is limited; sales 50 tons, to arrive, at 8¼c., 6 mos.; small lots from the store, to the jobbing trade, command 8½–8¾c. per lb. 6 months.

Zinc.—The market is quiet but firm; the receipts, however, are more frequent; Mossellman is selling in a small way, from wharf and from store, at 8¾–9c., 6 months.

PHILADELPHIA METAL MARKET, Friday, March 20, 1857:

Iron—	*From*	*To*	
Railroad Iron, per ton		$65 00	
Anthracite Pig Iron, No. 1, per ton		27 00	6 months.
" " " 2, "		26 00	"
" " " 3, "		25 00	"
Scotch Pig		32 50	"
Charcoal Cold Blast Pig Iron	35 00	38 00	"
Bar Iron, per ton	65 00	70 00	"
English Bar, common	62 50	65 00	"
" " refined	67 50	70 00	"
Swedish Bar	105 00	110 00	"
Fritzoe T. V. F. Bar	125 00		
Sheet, English, per pound	3¾	4¼	"
" Russian, "	13	13¼	"

Copper—	*per lb. 4 months.*
Bolts & Brazier's sheets	$0 35
American Ingot	0 29
Lead—	*per lb.*
Drop Shot	$0 07¼
Mould Shot	0 06¼
Bar Lead	0 06¼
Pig Lead	0 06¼
Zinc—	*per lb. cash.*
Sheet Zinc	$0 09

Tin—	*cash.*
Banca Tin	$0 37
Plates, I. C. Charcoal	12 00
" I. C. Terne	11 50
Steel—	
Best English Cast Steel	$0 16
2d Quality Eng. Cast Steel	0 14
German Steel	0 11
Round Machinery Steel	0 11
English Blister do 8 to	0 13

NEW PUBLICATIONS.

"A TREATISE ON LAND SURVEYING: Comprising the Theory developed from Five Elementary principles; and the practice with the chain alone, the compass, the transit, the theodolite, the plane table, &c. Illustrated by Four Hundred Engravings, and a magnetic chart. By W. M. Gillespie, A.M., Professor of Civil Engineering in Union College. Fifth edition. 8vo. pp. 464. D. Appleton & Co., 346 & 348 Broadway, New York."

We give the title of this excellent work *in extenso*, as furnishing a good synopsis of the contents, which we have examined with much care, and we will add, with entire satisfaction. The fact that a fifth edition has been called for, sufficiently indicates the estimation in which it is held by the public, and we cheerfully add our endorsement to the popular verdict.

"THE PHILOSOPHY OF THE WEATHER, and a Guide to its Changes. By T. B. Butler. D. Appleton & Co., 346 & 348 Broadway, New York." This is a handsome volume of more than 400 pages, each of which contains some fact worth knowing, and some ideas worthy of reflection. The author has successfully and pleasantly carried out his object, which he thus states in his preface: "I propose to deal with "*The Philosophy* of the Weather"—to examine the nature and operation of the arrangements from which the phenomena result; to strip the subject, if possible, of some of the complication and mystery in which traditionary axioms and false theories continue to envelop it; to endeavor to grasp *its principles*, and unfold them in a plain, concise and systematic manner, to the comprehension of "the many," who are equal partners with the scientific in its practical, if not in its philosophic interest; and to adduce a few general rules by which its changes may be understood, and, ultimately, to a considerable extent, foreseen. The work is handsomely illustrated, and is worthy of examination.

THE

MINING MAGAZINE:

DEVOTED TO

Mines, Mining Operations, Metallurgy, &c., &c.

VOL. VIII.—MAY, 1857.—No. V.

ART. I. — THE IRON MANUFACTURE OF GREAT BRITAIN — THEORETICALLY AND PRACTICALLY CONSIDERED. By WM. TRURAN, C. E. No. 16.

(Continued from page 321, Vol. VIII.)

SECTION XVIII.—FINISHING OPERATIONS ON MALLEABLE IRON.

GENERAL REMARKS ON IRON.

FROM the mill rolls the bar is taken to the cropping shears, or if the end is required to be cut perfectly square, to the circular saw. The cropping shears are usually employed in cutting mill bars, (iron to be re-worked,) and small merchant iron; but for the larger bolts and squares, the heavier descriptions of merchant bars, and railway bars generally, the saw is in universal requisition. The strain in shearing small rods while yet hot from the rolls is not great, and frequently is performed by light hand shears, constructed principally of wrought iron. Larger sizes are cropped in stronger shears, the class employed for mill bars and the general run of merchant iron weigh about five tons. They are furnished with steel knives from 12 to 16 inches long; owing to the heat communicated to them by the hot bar during the shearing, the steel is softened, which renders it necessary to change the knives every few hours. The knives for bolts and squares are provided with semi-circular and triangular notches to receive the bar; without this provision the end of the soft bar would be considerably flattened by the pressure on it during the operation of shearing.

Cold shearing is performed with heavier shears. The quality of the iron is more apparent, and the cut cleaner when performed on the cold bar with sharp knives. The heavy cropping shears, capable of shearing cold iron 6 by 1 inch, weigh with their connections from 15 to 20 tons.

The employment of saws dates from a very recent period; with the manufacture of rail bars in quantity, the necessity for an apparatus for cutting the ends perfectly square was very apparent, and resulted in the adoption of saws. The circular saw

for cutting iron bars measures from 8½ to 4½ feet in diameter, made of either steel or wrought iron plates about $\frac{1}{16}$th of an inch thick, mounted on an iron spindle, and stiffened, for the major part of their diameter, by stout iron face plates. A saw bench provided with friction rollers, stops and adjusting screws, and slides for moving it backwards and forwards, is fixed in a line parallel to that of the axis of the saw; its upper surface level with the mill floor, and 2 inches distant from the lower edge of the saw plate. The saws are driven at a high velocity by means of belts and spur gearing from the engine; 1,300 revolutions per minute is not too great. In Staffordshire a single bench with a saw at each end, cutting both ends of the bar simultaneously, is very generally used. In the Welsh mills two saws are mounted on a spindle about 4 feet long, and a bench provided at the outside of each. The inside bench is usually placed at a distance of 25 or 30 feet from the rolls, in a line with the finishing groove. The bar having been drawn on to the bench, with one end projecting beyond the inside saw, it is firmly held in its position by a suitable apparatus, while the bench is moved laterally until the saw has penetrated and completely divided the projecting end, when it is drawn back sufficient to allow the bar to be drawn lengthwise on to the outside bench, which is provided with an apparatus for adjusting the length. The forward movement of the outer bench against its saw completes the cutting of the bar, which is withdrawn to the hot filer.

In the cutting of some rail bars, great nicety in the length is required; and allowance has to be made for the contraction of the iron in cooling. If the bars were cut at one uniform temperature, the allowance could readily be ascertained; but owing to the different temperatures at which they are cut, provision has to be made in the screw stop, adjusting the length for frequent small variation. With two benches outside the saws, considerable accuracy in the length may be obtained by adjusting the stop; with the single bench between the saws, cutting both ends at one movement, the same exactitude cannot be obtained; and if cut singly, the absence of the fixed screw stop for adjustment causes much uncertainty.

Saws worked by an emission engine on the same spindle have been erected, and under certain circumstances are superior to those driven by belt and gearing. Where the saws are constantly at work, the latter mode is preferable, though expensive, if the saws should be situated far from the engine; but where they are only occasionally used, the steam saw is probably the cheapest. It can be erected at a comparatively trifling expense, at a considerable distance from the motive power. In the one, heavy shafting has to be kept in motion through the day, consuming power and stores; in the other, the steam is thrown on only when required, but during the period it is in operation the

consumption of power by the steam saw, measured by the volume of steam used, is immensely greater than that by the saw driven by belts and gearing; hence, the greater consumption of steam by the emission engine when working continuously, more than balances their low first cost.

If the benches are good, working freely and steadily, and the saws are truly set, revolving at a high speed, the end of the rail bar when steadily and slowly cut will have a polish equal to that produced with a smooth file. With less efficient benches, vibrating saws, and rapid sawing, the ends will be rough and serrated. Grinding has then to be employed in order to attain the desired finish.

The saws are furnished with coarse teeth on their edge, which are sharpened after 12 or 24 hours' working, according to the number of cuts made. Steel saws will cut from 600 to 700 bars before sharpening; iron saws will not cut more than half of this number. To prevent the teeth from heating and softening, the lower edge of the saw works in a bosh containing cold water. The sharpening is sometimes performed by filing; but where there are several saws at work, a more expeditious mode of restoring the angular sharpness of the teeth, consists in punching out a triangular piece with a powerful punch. The saw is placed on a revolving table level with the top of the die block; the table is furnished with an adjusting screw, by means of which the circumference of the saw is brought into the required position with the punch. This done, the operation of sharpening is very simple; the saw being carefully turned around by hand the breadth of a tooth at each stroke of the punch, which shears off at one cut what the file accomplishes in 10 or 12; care must be taken that the saw is not geared with the punch so deep as to cut away more than is necessary to restore the original angle of the tooth.

Cutting with the cleft and sledge is still practised to a limited extent. The end of the bar is brought to a red heat, held firmly in a heavy block cast with the half profile of the section at the bottom of a slot; a loose piece, with the remainder of the profile on its under surface, is placed on it and keyed down slightly on the rail. When thus held firmly, with the cast iron in close contact with the rail at the line of separation, the cutting may be performed with considerable neatness.

Rail bars are also cut cold by means of powerful vertical shears, a very complete specimen of which may be seen at the Cyfarthfa works. The block carrying the cutting knife is actuated by a cam shaft revolving at a height of 7 or 8 feet from the floor, and slides between planed guides set vertically in the large side standards. The fixed knife or die block is bolted fast to the bottom framing with countersunk pins, and is pierced with an orifice, the exact form of the section of the rail to be operated on.

The rail is placed on a turn table and rollers, level with the orifice in the die block. In operating, the end is projected through, when the vertical block and knife in the down stroke of the cam shaft shears it off. The first cut is seldom clean; to regulate the thickness of the succeeding cuts a screw-adjusting apparatus is provided at the rear, by which the quantity taken off and the polish ultimately given to the rail may be accurately determined. The cold shearing of rails is advantageous in one respect: they are cut at the same temperature, hence, greater accuracy in the length is obtained.

For cutting cobbles, large scraps, and other bars of considerable sectional area, a very powerful shears is constructed with an eccentric cam at foot. The block carrying the cutting knife slides vertically in guides, and rests directly on the cam, by which it is elevated at each revolution. In the heaviest shears of this class, bars 5 inches square are cut with the greatest facility.

The crop ends of rail bars are sometimes reheated and wrought into small bars; at other times they are combined with puddle iron, which has been rolled of a suitable section and re-manufactured into rails; but generally a difficulty occurs in the piling, arising from their irregular section. To reduce them to a better form they have been compressed under powerful squeezers, passed between suitably-grooved rolls to consolidate them, and passed under revolving cutters whereby the projecting parts have been shorn off. The description of rail end to be wrought should be taken into consideration in selecting the apparatus; in either case the operation is performed while the crops are hot from the sawyer. The flanch rails are wrought most advantageously in rolls having such grooves, that, on passing through three or four times, the flanches are turned over on the body of the rail end, which then is of a form favorable for piling. For bridge rails the cutters appear to be the most advantageous. They are made of wrought iron and steel combined, about 18 inches diameter, and are driven at from 25 to 50 revolutions per minute; the rail crop is inserted on the guides, and drawn forward by the revolving cutters, the flanches are shorn from the body. In piling, the strips of flanches are placed inside the rail, filling up the hollow, or they may be piled separately.

THE FIBROUS CHARACTER OF BAR IRON.

The fibre observed in bar iron, and which to a certain extent determines its commercial value, is produced by the peculiar action of the grooved rolls, combined with the agglutinous character at a certain temperature, forcing the atoms of iron to elongate in one direction only. In the fracture of a puddle ball when cold, we observe the iron in the form of large grains separated from each other by a thin film of extraneous matter. During

the process of shingling they are brought closer together, and in the bloom form a mass about 5 inches diameter by 16 inches long. Between the puddling rolls this bloom, by repeated rollings, is distended in length to a bar about 12 feet long, but is reduced in its section from 20 to 2.2 inches; each particle or atom of iron is consequently elongated to 9 times its former length, through the reduction of section. The fibre developed in the puddle bar is of a limited extent, and the presence of much of the original cinder is seen in the fracture.

Cut into short lengths and built to a pile, the bars lying longitudinally, the development of the fibre is heightened by a second rolling. If built of 3 by ¾ inch puddle iron 6 inches wide, the same in height, and 2 feet six inches in length, and rolled down to a bar 2 inches square, it will measure about 21½ feet long. The section of the pile composed of 16 pieces of puddle iron is reduced to a bar of 4 inches section; as each piece of puddle iron was formerly 20 inches in section, the square bar contains the same number of particles of iron in each inch of its section as existed in 80 inches of sectional area of bloom from under the squeezer of a hammer. Hence, the fracture of the bar produced from puddle iron is more dense, the fibres are more strongly developed and finer in texture, and owing to the quantity expressed in the second operation, the presence of cinder is less apparent.

If the square bars of No. 2 iron are cut, piled to a pile of similar dimensions, reheated and rolled to a bar of like section, the particles of iron in each inch section will be 720 times the number in the same area of the original bloom. On examination, the fibre is observed to be more numerous, forming exceedingly fine threads, the expulsion of an additional quantity of cinder has left the iron more pure, which is shown by its greater specific gravity, and the augmentation of tensile strength.

The fibre obtained by the repeated rollings may be neutralized, or even destroyed at any stage by alteration in the mode of rolling. If common puddle iron is cut into short lengths, and the pile built with the pieces laid crosswise, with only sufficient metal laid lengthwise at the bottom to retain them in this position while heating, and then rolled into a bar of the same dimensions as in the previous case, the iron will be utterly void of fibre, and break with nearly the same shortness, though offering a greater resistance than annealed cast iron, from which it differs in appearance only by its superior whiteness and the fineness of the particles of metal. By piling the common No. 2 iron in a similar manner, and rolling at right angles to the fibre of the pile, a bar is produced equally devoid of fibre, possessing the same shortness of fracture, but exhibiting greater fineness of metal.

By constructing the pile with a portion of iron laid in each direction, the finished iron will be fibrous on one side, and crys-

talline on the other. If the several layers are thin and cross each other, the tendency of one layer to develop fibre is neutralized by the opposite tendency of the other; and the extra process of heating and rolling, though improving the quality, will not result in the production of fibrous iron.

The employment of the best qualities of iron in the formation of the cross pile results in the production of a metal devoid of fibre, but distinguished from the non-fibrous metal of inferior irons, by its dense leaden texture, greater specific gravity, and superior tenacity.

If the bloom from the shingler is slabbed down between cylindrical rolls, varying the direction of the rolling each time, the resulting slab is devoid of fibre, presenting on fracture a scaly appearance; reheated and rolled into a thin plate, the iron is equally void of the fibrous character, but the fineness of the scale is increased. Cut, piled, and again reheated, the finished plate rolled in this way presents no appearance of fibre; the thready appearance observed in bar iron is wanting; in its place we have a laminated fracture. The original particles of iron, which in the case of bars are elongated in the direction of the length, are compressed into a flat scale.

Plates made from piles of No. 2 bars laid alternately along and across, are nearly void of this lamenated fracture; for its production the bloom requires to be rolled between cylindrical rolls, which offer no opposition to the distension of the atoms laterally. If rolled from cross piled piles, plates are nearly alike devoid of the fibrous and laminated structure. Hence we are enabled to determine from the fracture of the iron, the manner in which a boiler plate has been manufactured.

The greater value for numerous purposes, of iron rolled from piles having a portion of the bars laid at right angles to the others, is not generally understood by the manufacturer or consumer. When prepared from the inferior varieties of crude iron, the hardness and tenacity are largely increased; but when prepared from superior qualities the dense structure of the bar results in an increase of its specific gravity, with a corresponding improvement in its ductile, tensile, and general valuable properties. The cause of the superiority of the iron thus treated is not difficult of explanation. In the ordinary mode of piling and rolling, the bar is elongated in one direction, the original fibres are distended with each rolling, and no resistance is offered longtitudinally, to the degree of distension. In the bar manufactured from the cross pile the pressure exerted by the rolls acts endwise on a portion of the iron, compressing it to a fraction of its former length. The density appears to be greater than that due to the pressure on the cross piled portion, and is probably owing to the interlacing of the fibre at the half-finished stage. The very different character of the iron produced from ordinary

piles, compared with the iron produced from the same bars differently piled and rolled, is analogous to the effect produced by a continuous hammering in one direction, and the same bar subjected to alternate distension and compression by upsetting.

In the puddling forge, the value of the upsetting process on the bloom as resulting in the production of increased solidity is fully acknowledged. If the quality of the iron is thus early improved by pressure in this direction, it is evident that a repetition of the operation at each subsequent rolling will result in a corresponding improvement. In the mills, however, this is best accomplished, as we have shown, by disposing the greater portion of the iron that it may be subjected to the process during the rolling.

The fibre of bar iron is produced by rolling, hammering, or other pressure, while the metal is in a plastic condition, through absorption of caloric; it is not produced by any known means, when, through a diminution or excess of caloric, the plastic condition of the iron is destroyed; when cold, the fibrous character of bar iron is readily destroyed by rolling, hammering, or other pressure, and less rapidly by concussion and vibration.

IMPROVING THE QUALITY OF CAST AND MALLEABLE IRON.

Various modes of improving the quality of bar iron, by the addition at one or other of the stages of its manufacture of metals and oxides, have been devised. In all propositions, however, for the improvement of malleable iron by the incorporation therewith of foreign ingredients, it should be borne in mind that while it is possible thus to heighten a single characteristic, the inevitable result is to lower the general quality of the iron so treated. In seeking to improve the general quality it should be distinctly understood that a bona fide improvement can result only from the abstraction of an injurious alloy; the substitution of a less for a more injurious alloy; or the addition of a metal of a quality superior to that of the iron under treatment. But under no circumstances whatever can the mere addition of substances, or metals of inferior qualities, improve the general qualities of the iron; which are heightened, and developed with every degree of refinement, and debased with every adulteration.

The list of substances capable of being alloyed with iron is large, but their employment as a means of improving the general quality is invariably attended with opposite effects. The presence of carbon, by lowering the temperature of fusion, increases the fluidity of cast metal; but with this alteration,—the qualities of hardness and tenacity are reduced in nearly the same ratio. Silicum in quantity seems to impart additional hardness, but is attended with an equally great deficiency of tenacity, and materially impairs the ability of the metal to withstand crushing and abrading forces.

The tenacity of cast iron of a low specific gravity, and consequent inferior quality, may be improved by remelting, and the incorporation of wrought iron scraps of a superior tenacity; the improvement in quality by this treatment nearly disappears when the cast iron is of a high specific gravity. And of the improvement occurring to irons of low quality, debased by the presence of an excess of carbon, by far the largest portion is due to the increase of density, and consequent greater purity which follows on the partial oxidation of the volume of carbon during the operation.

The superior strength of air furnace castings is generally acknowledged by iron founders; but the common explanation of its being due to a greater homogeneity, consequent on the remelting of the crude iron, is altogether erroneous, and has arisen from a deficiency of experimental researches on the subject. We have found that the simple operation of remelting invariably increases the density and tenacity of crude irons of gray quality, the improvement being greatest with those containing the largest volume of carbon; and that a second remelting results in a farther increase of these qualities, which continue to augment with successive remeltings, until the iron has attained a high degree of refinement and increased its tensile strength by fully one half. The number of remeltings necessary to the development of the tensile powers of the metal, varies with, and is directly proportional to the volume of carbon to be liberated, but may be largely reduced by prolonging the period to which the molten iron is exposed to the decarbonating influence of the carbonic acid of the reverberating column. With white irons from blast furnaces consuming a minimum quantity of fuel, the improvement is not so marked. Containing a lesser volume of carbon, with a greater quantity of metalloids more difficult of oxidizement, the act of remelting is attended with a larger waste of metal in proportion to the volume of alloy removed. Since, therefore, the maximum tenacity is not attained with a single remelting, and microscopic examination fails to detect any irregularity in the structural arrangement of the blast furnace iron, we conclude that the superiority of air furnace castings is principally due to the greater purity of the metal, which necessarily results from remelting.

But while maximum tenacity is attained only by remelting and mechanical subsidization, the operation results in a corresponding deprivation of fluidity, and the iron so treated, after the third or fourth fusion, is not adapted for small castings, or the filling of sharp angles in larger ones. And with a succession of remeltings, all cast irons, especially the hot blast varieties, and such as have been produced from a burden composed wholly or partly of hematite, are subject to unequal contraction in cooling, sinkings on the surface, and, where the pieces are angular of large dimensions, rarely solid throughout.

Iron possesses the greatest density and tenacity when in the pure state; the presence of any other metal or matter in alloy reduces its density, and diminishes in a more rapid ratio its tensile strength. The crude iron of commerce ordinarily contains about 80 per cent. by volume of metallic iron, and 20 per cent. of an alloy uniformly specifically lighter than pure iron, and possessing tensile strength of the lowest description. The extent to which this property is deteriorated by the character and volume of the alloy, is a subject of paramount importance to the manufacturer and consumer of iron, but one on which hitherto, owing to its costliness and the extreme delicacy of manipulation demanded in the inquiry, no adequate experiments have been made. By a limited series, we ascertained that the tenacity in the various stages of manufacture was nearly in the ratio of the tenth power of its specific gravity; and that at the final resistance offered by the iron when converted into blister steel and severely hammered to a specific gravity of 7.92, the tensile strength averaged 84,000 lbs. to the square inch. The dependence and direct connexion of the tenacity and general good qualities on the specific gravity is not generally admitted, though in the practical operations of the manufacturer its existence is everywhere manifest. The production of a superior iron possessing great tenacity, but of a low density, is impracticable; inferior density is invariably accompanied with weakness. But while there is this inseparable connexion between superior density and a high density, through design or inattention the quality may be impaired without sensibly altering the density. And whilst this mode of estimation correctly determines the development of this property, we would remark that the results with one iron are not applicable to determine, by comparison, the results at an intermediate or final stage in the manufacture of another iron, which may be estimated by its final density and tenacity in the manner described.

THE DIFFERENCE CONSTITUTING CAST AND WROUGHT IRON, AND THE WELDING PROPERTY OF METALS.

Cast iron it is generally supposed differs from malleable iron in the difference of degree of alloy; the greater volume constituting cast iron, the lesser volume malleable iron; and a farther diminution resulting in the production of steel. But while the reduction of alloy during the processes of converting cast to malleable iron, and the necessarily greater purity of the latter must freely be admitted, there are reasons for believing, that malleability is not produced by, nor dependent on a given degree of purity, but results from the action of mechanical agency on the mass under operation, whilst possessing a certain temperature and agglutinous character. Crude iron may be refined by fusion and subsidization, yet retain all the essentials of cast

metal, and be utterly devoid of malleability. And large quantities of malleable iron are being made containing a greater percentage of foreign matter than crude iron of other makes; the conversion of this latter, however, into malleable iron, though possessing a minimum volume of alloy, can only be accomplished by the deprivation of a portion, and the production of an iron of greater purity than the former. Hence, we conclude, that the greater purity of malleable iron from a given source, compared with that of the crude iron, is the result, rather than the cause of the malleability, which arises from the manipulation to which it is subjected during manufacture.

All metals are malleable to a great or lesser extent, but the degree of extensibility as well as the temperature at which it may be effected is not alike, and in the same metal varies with the degree and character of the alloy. Cast iron, though usually considered a brittle substance, possesses extensibility, when its reduction of temperature from the liquid state has by prolongation been imperceptibly lowered; but if the temperature has been suddenly brought down by contact with cold metal or other ready conductor, it is incapable of extension. Where the mass is large, the central portion, losing its caloric at a slower rate, often will be found to a degree malleable, while the outside is deficient of this property. And in the case of horizontal castings of considerable thickness, it is observed that the surface possesses malleability of which the lower portion is wholly destitute. The difference in composition cannot account for this loss of malleability; for we have no evidence of the mere circumstance of losing its caloric more rapidly, causing an alteration in the relative proportions of the mass, though it may affect the character of the alloy. But the annealed iron possesses the malleable property only within a limited range of temperature; heated to about 400° it disappears, and does not again reappear with the infusion of caloric within the fusing point.

In this respect we see a complete difference in the character of the malleability in the crude and finished iron; for while in the former the property is diminished and ultimately destroyed with the infusion of caloric, in the latter it is augmented, and attains a maximum development after absorbing a sufficiency to reduce cast iron to the liquid form.

The malleability of wrought iron is developed only by dexterous manipulation, while the crude iron possesses a degree of plasticity in its semi-liquid state, and unless immediately subjected to the action of the rolls or hammer, reverts to its normal condition of brittleness. By the rapid application of a varied pressure on the mass while it is in the plastic condition, the agglutination of the atoms of iron is effected, and during the subsequent elongation of the mass by pressure, they are distended longitudinally, until through loss of caloric the ductility of the

alloy is destroyed and their continuity broken. Crude cast iron is incapable of extension with the mere infusion of caloric; the atoms of iron roll on each other, and the alloyed matter is deficient of the agglutinous character necessary to the development of the malleable property. After being subjected to an operation whereby the atoms are agglutinated and distended, the mass, by the re-infusion of caloric, may be distended indefinitely; but below a certain temperature, the brittleness of the alloy limits the quantity of distension. The metallic iron possesses the superior absorbent and retentive powers during the process, and its ductility is comparatively unimpaired by the loss of caloric; the alloy on the other hand possesses inferior powers, and with the escape of caloric loses its plasticity, becomes excessively hard and brittle, and if the distension of the iron by lateral pressure be continued, the compression of the atoms of alloy into the softened iron destroys its tenacity, and renders it either of a red or cold-short quality, according to the volume of alloy and temperature of solidification.

Wrought iron is distinguished from other metals by the facility with which two or more pieces may be united together and retain unimpaired their tenacity. The property of welding on the infusion of heat belongs to all metals, whether cast or malleable, but is most apparent in iron. It is produced by the infusion of caloric until the iron and metalloids of the entire mass are softened, and the surfaces to be united reduced to a semi-liquid state. The comparatively large quantity required to liquefy wrought iron, enables the softening and partial fusion to be successfully conducted. Cast iron and other metals may be united by fusion, but during the accession of caloric, owing to the lesser quantity required and the inferior melting temperature, only a momentary period elapses between the softening and complete liquefaction of the entire mass treated, and the rapidity also with which it escapes, does not permit of the manipulation necessary to the effectual consolidation of the pieces. In the case of cast iron, the difficulty is increased by the large volume of matters in alloy: melting at various temperatures, the mass is not equally and simultaneously heated; brought in contact with each other, the union of the pieces is obstructed by the different conditions of temperature presented by the respective constituents.

The interposition of foreign matter, by impairing the agglutinous character of the mass, prevents the complete union of the pieces. The fumes of metals oxidizable at an inferior temperature also interferes with the union; if present in sufficient quantity, they alter the character of the iron from its usual tenacity and ductility, to the opposite extremes, and destroy the welding property. Compound metals having an ingredient sublimable at a temperature lower than the fusing point of the most refractory, cannot be united by welding; the gases of the inferior metal interpose and prevent the agglutination of the atoms.

MANUFACTURE OF WROUGHT IRON DIRECT FROM THE ORE.

The production of wrought iron direct from the ore—the original mode of manufacturing,—has engaged the attention of numerous practical and scientific men, and is practised to a limited extent abroad; but the attempts made to reinstate it in this country have hitherto been unsuccessful, commercially speaking, and, though the ores and fuels we possess are unquestionably superior to the foreign for the purpose, fusion in the blast furnace, and conversion into malleable iron by the puddling process, is pursued with all the bar iron now manufactured.

The conversion direct into malleable iron dispenses with the blast furnace and appendages, and the intermediate processes of refining and puddling, and if successful should result in the production of a finished bar of superior quality, with a smaller consumption of ore, and at a proportionately lower cost. In all experimental operations of converting on this plan, the bar is of inferior quality, the consumption of ore larger, and the cost of production augmented over that attending the manufacture with blast furnaces and refineries. The causes tending to produce this difference between the results of theory and practice are numerous, but will receive from us only a brief notice.

The ore to be converted is ground to a coarse powder, and in mixture with a quantity of carbonaceous matter similarly divided, charged into a reverberatory furnace not unlike the ordinary puddling furnace. The draught is forced to the production of a high temperature, reducing the ore to a semi-liquid state, when, by dexterous manipulation on the part of the operative, the metallic iron is separated from the extraneous matter, balled up, and shingled as in the usual manner. The theory of the operation is simple. The carbon of the carbonaceous matter is consumed by uniting with the oxygen of the ore, which is left free to agglutinate into a mass. The Beaufort black band was converted into malleable iron, though after a few experimental trials the operation was discontinued. The principal objection to its extensive adoption seems to lie in the difficulty of effecting a complete separation of the extraneous metalloids of the ore. In the blast furnace it is accomplished by mechanical subsidization in the hearth, and the extraction of the metallic iron from the low level; in the direct mode of manufacturing it is effected to a degree by severe manual labor, which being skilled, commands a comparatively high price, and materially enhances the expenses incidental to the process.

The prolonged exposure of the metallic iron to the oxidizing influence of the flame and gases during the process of separation from the alloyed matters, results in a considerable waste of metal, and accounts for the comparatively inferior yields.

To obviate this loss, and to economize the fuel and labor de-

manded, the ground ore and carbonaceous matter has been subjected to the necessary heat in a closed supplementary chamber, whereby the combustion of the carbon is slowly carried on at the expense of the oxygen of the ore, but at a sufficiently low temperature to avoid oxidizing the mass. From the chamber it is drawn as required into the furnace, balled up and shingled, the deoxidized ore agglutinating without undergoing the puddling process, which being essentially a decarbonating process, is unnecessary with the minimum volume of carbon consumed in the deoxidation of the ore in the close chamber.

Ground carbonaceous ore may be substituted for the carbonaceous matter, and mixed in the necessary proportions with the same ore calcined, or with raw hematite; the deoxidation of the latter can be effected without the usual ground coal, at a corresponding reduction in the expense. In this respect the possession of ores of such varied character gives the iron masters of this country an important advantage over their foreign compeers, and should this mode of manufacture at some future day become more profitable than at present, enable them to maintain their supremacy in the trade. The rich carbonaceous ores of Scotland or Wales, mixed with the hematites of Lancashire or West Cumberland, or other similar ores, reduced in suitably constructed furnaces, may be converted into malleable iron at costs considerably under those incurred with the blast furnace and subsequent decarbonating system.

With existing modes of operating, the advantages of direct conversion are principally confined to the comparatively small capital required to establish the manufacture, which may be on the smallest scale, yet to a corresponding extent profitable. Hence, it is especially applicable to new districts, requiring an immediate small supply, and to countries deficient in the capital necessary for carrying on operations on the largest scale with blast furnaces, and attendant refining and puddling furnace. To establish on a sound basis works consisting of blast furnaces, refineries, puddling forges and rolling mills, a capital of at least £20,000 per blast furnace, where there are four, is required; with a fewer number more. In the direct mode wrought iron in proportionably smaller quantity may be manufactured, with a capital of only one-twentieth, or one-thirtieth of this sum. In this respect, therefore, it is more advantageous, and merits the preference over the established system.

Section XIX.—Power Expended in the Various Processes of the Manufacture.

In the course of experiments having for their object the economical application and maintenance of the necessary power for

manufacturing, we ascertained that the force absorbed in the various operations was nearly as follows. The crude iron being produced from lean argillaceous ores, with a small burden of hematite and cinders.

BLAST FURNACE.

Compressing the blast to a density of 3 lbs. on the square inch, for every one hundred tons of crude iron smelted from argillaceous ores weekly, 55 H.P.; or allowing for friction and leakage in the engine, 66 H.P. The horse power being 33,000 lbs., lifted one foot high per minute.

Compressing the blast to a density of 3 lbs. for every 100 tons of crude iron smelted from rich carbonaceous ores weekly, 22 H.P.—equal to 27 H.P., inclusive of friction and unavoidable loss.

Compressing the blast to a density of 3 lbs. for every 100 tons of crude iron smelted from a burden composed of hematite and cinders weekly, 52 H.P.; or inclusive of friction and loss, 63 H.P.

REFINING FURNACE.

Compressing the blast to a density of $2\frac{1}{2}$ lbs. to the square inch for refining forge iron in the running-in fire, for every 100 tons refined plate metal produced weekly, 13 H.P., equal to 16 H.P., including friction and waste.

Compressing the blast to a density of $2\frac{1}{2}$ lbs. for refining heavy castings and scraps of gray quality for every 100 tons of refined plate metal produced weekly, 24 H.P., or 29 H.P. gross.

PUDDLING FORGE.

No. 1. Driving 18 inch puddling train, consisting of pair of finishing and pair of roughing rolls, double-ended squeezer, and 2 pairs of puddling cropping shears, at a velocity of 55 revolutions per minute. Power expended in maintaining the train, heavy machinery, squeezer and shears in motion at this speed, 40 H.P.; additional power when in full work, rolling and squeezing at the rate of 300 tons weekly, representing the force expended in shaping the iron, 34 H.P. Total power required to drive puddling train at this speed and rate of production, 74 H.P., rolling iron, 3 inches wide, by $\frac{3}{4}$ inch thick, puddled from refined metal.

The 40 H.P. expended in driving the machinery light, at a speed of 55 revolutions per minute, was absorbed as follows:—

Force exerted in overcoming friction and *vis inertiæ* of engine	5
Ditto, heavy gearing, consisting of crank and fly wheel shafts, spur gearing, &c.	13
Ditto, bevil gearing, crank, spindles, and cropping shears.	8
Ditto, roll train, consisting of rolls, double bearing pinions, and connecting spindles	15
Ditto, squeezer crank and squeezer	4

By other experimental analyses we ascertained that, when when working full, the 74 H.P. was thus absorbed:—

By the engine employed	7
By heavy gearing	15
By shear spindles and shears	4
By roll train	37
By squeezer	11

No. 2. Driving puddling train, rolls, squeezer and shears similar to the foregoing, but making 82 revolutions per minute, with a reduced speed of the engine employed. Power absorbed by the engine and machinery at this speed of driving 19.5 H.P.; absorbed by the roll train when driven light, 28.5 H.P.: total absorbed by engine, machinery, rolls and squeezer, when neither rolling nor squeezing, 48 H.P. Additional power absorbed when rolling and squeezing at the rate of 360 tons weekly, 67.5 H.P—representing the force expended in reducing the iron to bars 3 inches by ¾ inch from boiled pigs. Hence, the gross power expended in driving this train amounts to 115.5 H.P.

The mean power absorbed by the forge hammer delineated in Plate 11 is less than that absorbed by the double ended squeezer, but whilst in motion the former requires a larger available power; at 19 revolutions of the cam ring per minute, the power absorbed including *vis inertiæ* and friction amounts to 16 horses.

ROLLING MILL.

Driving 18 inch rail train, consisting of pair, roughing pair, finishing, and double-bearing pinions, high pressure horizontal steam engine, heavy gearing, with cropping shears, 8 straightening presses, saws, and minor connections. Rolls driven at the rate of 85 revolutions per minute. Power absorbed by engine, machinery rolls, &c., when running light, 71 H.P.; additional power absorbed when rolling flanch rails, 168 H.P. Total power absorbed in driving a rail train capable of making 600 tons of rails weekly, 239 H.P. By analysis we ascertain that of this number of horses power there are absorbed in

Friction and *vis inertiæ* of engine	12
Driving heavy gearing	22
Absorbed by roll train	179
Driving shear spindles and shears	6
" 8 straightening presses	12
" pair circular saws	8

The mean force absorbed by the train amounts to 179 horses, but the power is exerted at intervals of a few seconds; and during the act of rolling, the power delivered by the engine, and the accumulated force of the heavy fly wheel employed, varies from 332 to 485 H.P.

Driving 18 inch bar train, consisting of pair roughing and pair finishing rolls, cropping shears, 4 straightening presses, and

pair of circular saws. Power absorbed in driving machinery of 3 trains and their connections when running light, 52 H.P. Power absorbed by each train of rolls when running light, 21 H.P.; additional power absorbed by each train when rolling 1¼ inch bolts and squares, 29.5 H.P.; ditto when rolling 6 by 1 inch flat bars, 112 H.P. Total power absorbed by train of bar rolls rolling large flats, 159 H.P.; ditto of a mill of 3 trains rolling 6 inch flat, 1¼ squares and 1¼ rounds, with the connections detailed, 286 H.P.

Driving 12 inch bar mill, consisting of 3 roughing and pair of finishing rolls, pinions and nuts, with 2 pair cropping shears; engine horizontal high pressure. Power absorbed driving light, 140 revolutions per minute, 26 H.P.; additional power when rolling bolts and squares, mean of ⅝ to 1 inch, 23 H.P.;—total 49 H.P., mill capable of rolling 80 to 100 tons weekly.

Driving 12 inch bar mill, consisting of pair of roughing and pair of finishing rolls, pinions, heavy cropping shears, &c., driven by an independent engine. Power developed when rolling flats 1½ by ⅜, including friction, &c., of engine, gearing and shears, 32 H.P.

Driving train of 8 inch merchant bar rolls, consisting of 3 roughing, 3 ovals, and pair of finishing, working at the rate of 220 revolutions per minute. Power expended in maintaining in motion engine and machinery, 17 H.P.; absorbed by train when running light, 24 H.P.; additional when rolling ½ inch flats, 14 H.P.; ditto when rolling ¾ inch flats, 21 H.P.; ditto when rolling 1 inch guide bolts, three lengths, 18 H.P.;—total power absorbed by a mill producing ¾ inch flats, 62 H.P.

Driving train of 8 inch merchant bar rolls, similar to the above, but driven by independent engine and machinery; rolling short lengths of bolts and squares up to ⅝ diameter; mean power when on ½ inch guide bolts, including friction and *vis inertiæ*, 54 H.P.

Driving pair of 4½ feet rail saws, 820 revolutions per minute by spur gearing and belt; independent engine, horizontal, high pressure, 11 H.P.

Driving pair of double rail straightening machines, making 28 strokes each per minute, and straightening from 80 to 100 tons of rails per press per week, 7 H.P.

Driving heavy cropping shears, cutting mill bars 6 by 1 inch, 65 cuts per minute, and shearing 120 tons daily, 9 H.P.

An approximation to the gross engine power employed in the iron manufacture of this country, and the mining operations connected therewith, may be obtained by a reference to the power employed at the Dowlais works, where the crude iron produced by the blast furnaces is converted principally into rail iron and other heavy bars. The proportion of power to produce is considerably over that prevailing in Scotland, and the Northern dis-

tricts, but is under the power employed in Staffordshire and others largely manufacturing the smallest size bars; and may be considered as being near the mean of the districts.

The power delivered off by the Dawlais engines in the present year (1855) is nearly as follows:

		H.P.
4	Pumping engines, draining, colliery, and iron ore workings, and supplying work with surface water . . .	496
16	Engines winding out of coal and iron ore pits . .	1134
14	Engines at incline planes and secondary operations .	668
11	Locomotive engines, hauling coal and ore to works, and produce to and from furnaces	580
2	Engines driving clay mills, pug mills, and brick moulding machines	76
5	Blowing engines	2154
10	Forge and mill engines	2165
2	Engines driving lathes, and shearing cold iron . .	35
	Total horse power . .	7308

The annual production of this works, amounts to 108,576 tons of pig iron; the annual production of the United Kingdom 3,585,906 tons; calculated on the above power the manufacture is conducted with engines of the collective power of 242,000 horses.

ART. II.—ON THE GEOLOGY AND PHYSICAL GEOGRAPHY OF NORTH AMERICA.*—By Professor HENRY D. ROGERS, from the United States.

THE speaker stated that his object in this discourse was to present a condensed view of the physical features and geological outlines of North America,—a country highly interesting, from the majestic scale of its natural structure—from its peculiar position on the earth's surface, lying intermediate between Europe on the one hand, and Asia and Australia on the other—as a half-way house to connect the commerce and civilization of the world; and tenanted by an energetic people, essentially a composite nation, made up of the enterprising and ardent spirits who have gone from the various more civilized countries of Europe.

Taking a comprehensive but rapid survey of the general physical features of North America, we find it presents but two great slopes, one sinking towards the Atlantic, the other towards the Pacific, divided by a lofty mountain axis, the Chippewayan or

* Notices of the Meetings of the Royal Institution of Great Britain, Feb. 8th, 1856.

Rocky Mountain chain, the true water-shed or backbone of the continent.

From either base of this chain, where the plane of the country has an elevation of 5,000 to 6,000 feet above the sea, the continent slopes eastward and westward, interrupted by only two important intervening mountain swells—the Atlantic or Appalachian chain, and the Pacific or Californian. These oceanic chains only partially turn the drainage; some of the largest rivers, the Susquehanna and Kanawha, in the one case, Frazer's River and the Great Columbia in the other, cutting quite through them. Another broad swell of the surface crosses the continent, nearly westward, from Labrador to the sources of the Columbia, passing between the Lawrentian Lakes and Hudson's Bay, and between the sources of the Missouri and those of the Saskatchawan. From this the continent slopes gently northwards, to its Arctic shores, and southwards, to its Mexican. All these slopes are well indicated in the river drainage.

Looking closer, there appear seven grand primary divisions of the surface of the continent, comprising two broad continental plains, three great belts of mountains, and two narrow oceanic slopes.

A.—The largest of these areas is the GREAT CENTRAL PLAIN, extending from the Gulf of Mexico to the Arctic Sea and Hudson's Bay, and from the Appalachians to the Rocky Mountains, a wide continental region of table-lands, plains, and gentle slopes.

It consists of two physically different districts—the one a western region of elevated table-lands or steppes; the other, a parallel eastern zone of less average elevation, comprising three great basins or plains, of river and lacustrine drainage.

I. *The Western Steppes.*—These constitute a wide zone, east of the Rocky Mountains, about 350 miles broad, ranging from the 28th to beyond the 60th degree of latitude; including, indeed, the Arctic Highlands, east of Mackenzie River. From the Arkansas to the Upper Missouri this plateau has a mean level above the sea of about 4,000 feet, rising, at the base of the mountains, to 5,000, and at the highest east and west swell of the surface, to 6,000 feet. The general eastern boundary of this great terrace, which has a mean height of about 2,000 feet, follows approximately the meridian of 98° W.; but northward of the Nebraska and Missouri, it is not so well defined. Rising to the foot of the Rocky Mountains, by successive steps and gentle slopes, the plain contains one escarpment, which being much more conspicuous than the rest, seems to divide it into two belts. This, which coincides with the meridian of 101° W., is best marked between lat. 32° and the Arkansas, but extends to the Forks of the Nebraska, and yet further. From the Pecos to the Nebraska, the upper plateau is about 3,500 feet above the sea, and is 1,000 feet higher

than the table-land east of it. This entire Western belt, as far north as the Missouri, is a barren and thirsty treeless desert, especially in its southern half. It is without verdure, except along the very attenuated streams, and at certain seasons is entirely rainless. North of the Missouri it is better irrigated, and more grassy, and includes many rivers and lakes.

The lower terrace resembles the upper in its flat monotonous surface, its treeless wastes, and arid summer climates, but it is rather more grassy, and its southern streams are better fringed with trees and verdure. All the rivers, from the Pecos to the Arkansas, issue from the upper table land to the lower, through deep narrow sluices (cañons), between precipices of enormous height. For more than 400 miles, from the Brazos to the Arkansas, the lower treeless plain is fringed by a remarkable belt of woodland, from 5 to 25 miles wide, which is called the "Cross Timbers." This strip of forest forms the western boundary of the fertile and better watered still lower plain of Texas, a region of verdant prairies, dotted with natural parks, and clumps of live-oaks and other noble trees.

II. *The Eastern Basins.*—This vast tract, embraced between the north-west base of the Appalachian Mountains and the eastern border of the elevated western plateau, is a broad well-watered plain, full of streams and lakes, rising nowhere higher than 1,500 feet above the sea; and in few districts higher than 500 to 700 feet. It includes three large natural basins of drainage—that of the Mississippi, and its affluents east of the high western steppes; that of the Lawrentain Lakes and their feeders: and that of the southern, western, and eastern tributaries of Hudson Bay.

1. *The Mississippi Basin.*—This wide river basin slopes so gently southward that its height at the mouth of the Missouri, nearly 700 miles from the sea, is only 388 feet; and at the Falls of St. Anthony, 1,150 miles from the sea, it is no more than 856 feet. Its eastern and western slopes are likewise extremely gentle, as shown by the fact, that the elevation of the plain at Pittsburgh, nearly 600 miles from the Mississippi, eastward, is only 679 feet; and in the opposite direction, at the mouth of the republican fork of the Kansas, it is still but 927 feet. The basin of the Mississippi and Missouri is divided from that of Hudson Bay, —from the Western end of Lake Superior to the foot of the Rocky Mountains, but eastward from the drainage of the Lawrentian Lakes, by a low water-shed, nowhere higher than 1,300 feet, and in few districts more than 1000 feet above the sea. This whole Mississippi plain enjoys a soil and climate of rare fertility, and possessing enormous coal fields and other mineral wealth, is endowed with extraordinary agricultural, commercial, and manufacturing resources. From the western slopes of the Appalachians to the Mississippi, the Wabash, and Lake Michigan, nearly the entire surface was originally clothed with forest; but west of those

limits, the vast plain consists of gently-rolling verdant prairies, intersected by strips of woodland along the valleys of the streams; and on the south-west, sprinkled with parks, and scattered clumps of trees.

2. *The Lawrentian Lake Basin.*—This middle basin, from the head of Lake Superior to Lake Ontario and the Ottawa, is separated on its south from the basin of the Mississippi and Ohio, by the low water-shed bordering its lakes; and on the north, from the southern feeders of Hudson's Bay, by a somewhat higher water-shed, ranging from Missabay Heights, where the summit tract is about 1,500 feet high, north of Lake Superior and the Ottawa, and gradually declining to the sources of the Saguenay. It is a curious feature of this basin, that its western rim is only 50 miles west of the head of Lake Superior, the southern and northern water-sheds which embrace it, uniting in about long. 92° 50′. An unusual portion of the surface of this basin is covered with water. Its five great lakes contrast their magnitude with the smallness of the area which supplies them; for both the water-sheds are in relatively close proximity to these basins. In some districts the southern water-shed is only a few miles distant from Lakes Michigan and Erie; while some of the streams descending southward are more than 2,000 miles from the Gulf of Mexico. But this anomaly vanishes, when we recognize in these lakes only expansions of the Upper St. Lawrence, their southern water-shed then taking its true half-way position below the Gulf of St. Lawrence and the Gulf of Mexico. The basin of the five lakes is a wide level plateau falling eastward, by successive stages, from a level at the surface of Lake Superior of 628 feet, to one of 232 feet at the surface of Lake Ontario. Its confining water-sheds are only the eastern extensions of the great central swell of the Continent, forking where it approaches Lake Superior; one branch ranging northward, the other southward, of this long and narrow basin.

3. *The Hudson Bay Basin.*—This almost rivals in size that of the Mississippi. It is separated from that of the St. Lawrence by a low crescent-shaped curving water-shed, beginning in the highlands of Labrador and the Watchish Mountains, and extending westward to the Missabay Heights. To the south-west and west, its boundary is the vaguely-traced limit of the western plateau, prolonged north-north-west, from the Missouri towards Lake Athabaska. This great basin is a region of innumerable tortuous streams and inosculating lakes and swamps, converging their drainage into Hudson Bay. In the northern half of the continent, the larger rivers which enter Hudson Bay, as the great Saskatchawan, descend from the base of the Rocky Mountains, across the low water-shed, which forms the western rim of this basin; thus linking it hydrographically with the high western plateau, and establishing in a wider sense, one great hydrographic basin

from the Watchish to the Rocky Mountains, north of the east and west swell of the continent. The general elevation of the extensive rim of the Hudson Bay Basin, is scarcely any where higher than 1,600 feet above the sea; the average level of the whole girdle probably not exceeding 1,000 feet. It is a cold, inhospitable, and snowy district, its rocks deeply overlaid with sterile drift, and its surface extensively covered with a net-work of waters and wet swamps.

B. THE APPALACHIAN MOUNTAIN ZONE.

This Atlantic mountain range embraces the whole belt of mountain ranges, extending from the Gulf of St. Lawrence at Gaspé, to Georgia and Northern Alabama. It consists of two divisions—a north-eastern, ranging from Gaspé to the valley of the Hudson; and a south-western, thence to the interior of Alabama; the total length of the chain is about 1500 miles, while its breadth varies from 150 to 200 miles. In the chief divisions of its length it is a wide complex belt of many parallel ridges, whose crests nowhere ascend much beyond 4000 feet above the sea; the base of the chain, where highest, being about 1,800 feet above the sea level. From Alabama to the Hudson, the Appalachian chain is the water-shed between the Atlantic rivers and those of the Ohio and Lake Ontario; and from the Hudson to the Gulf of St. Lawrence it separates the drainage of those flowing to the Atlantic from the shorter streams entering the St. Lawrence. The Hudson valley does not entirely separate this long, nearly continuous mountain system. A depression of the continent to a depth of only 300 feet, would let the ocean through from the Gulf of St. Lawrence to the Bay of New York, and interpose a strait, nearly as broad as that between England and the European continent, between the main land of North America, and the even now half insulated districts of New England, New Brunswick, and Nova Scotia. That this great transverse depression of the surface, now uniting the estuaries of the St. Lawrence and the Hudson, was once thus actually submerged, is proved by indisputable geological monuments, consisting of oceanic clays containing marine pleistocene tertiary fossils.

The *North-eastern* section of the Appalachians contains as its principal chain the Green Mountains, a long belt of parallel and swelling ridges commencing in the Nôtre Dame range, south of the St. Lawrence, in Lower Canada, and terminating at the Schuylkill River, in Pennsylvania. These mountains at the Hudson, under the name of the Highlands, are cut to their base by that tidal river. In Vermont their rounded summits are 4,000 feet high, but on the Hudson they nowhere exceed 1,600 feet. The White Mountains of New Hampshire, and the Adirondac group in the north-east corner of New York, are lofty, outlying

masses, subsidiary to the Appalachians. They consist chiefly of the crystalline rocks. Their highest peaks exceed 5,000 feet, and that of Mount Washington, the loftiest east of the Rocky Mountains, is 6,428 feet above the sea level.

South-western Appalachians.—From the Hudson and Mohawk to middle Alabama, extends the other great division of the Appalachian chain, marked by an extraordinary parallelism, length, narrowness, steepness, and evenness of its numerous ridges. Its south-eastern belt, the most undulating and picturesque, is the Blue Ridge of Virginia, and the Smoky or Unaka Mountain range of Carolinas, Georgia, and Tennessee; it is nearly identical in geological structure with the Green Mountains, and resembles them in contour and scenery. Its highest crests, which are in North Carolina and Tennessee, reach to 4,000 and 5,000 feet above the sea. The Rocks of the Blue Ridge and Green Mountain chains, are chiefly ancient metamorphic strata, as gneiss, talcose, and chloritic schists and highly-altered argillaceous and sandy strata low in the palæozoic system, including, indeed, some of the oldest fossiliferous formations: these stratified masses are penetrated by igneous veins and dykes.

To the north-west of the Blue Ridge, and separated from it by a long continuous plain, called the Great Appalachian Valley, runs a parallel range of the middle Appalachian belt, traceable from the St. Lawrence to Alabama. This central zone of mountains consists of long narrow level ridges, divided by narrow longitudinal valleys, and cut to their bases by sharp deep ravines permitting the passage of the rivers. These ridges, caused by excessive erosion of the parallel waves of the strata, of which the central Appalachians consist, are linked into groups of several parallel crests, some of them remarkably straight for great distances, others gently curving. In many instances two narrow mountain crests unite at the two extremities to enclose a deep trough-shaped valley; some of these valleys, with their mountain borders, having a remarkable resemblance to a long narrow canoe or skiff. One class have a synclinal structure, the highest strata being in the bed or centre of the valley, and the hard lower rocks forming the enclosing parallel mountain crest. The other class are anticlinal in their form, a powerful erosive action of waters having carved them out by cutting through the crests of the original crust-waves, and scooping down to the softer lower strata. In some portions of this middle belt the long narrow ridges unite in wider mountain table-lands of the general height of the chain.

The rocks of this long middle Appalachian belt are exclusively palæozoic strata, comprising all from the base of that system to the upper coal measures inclusive. Scarcely a single igneous dyke or mineral vein intrudes itself into this, or the next more western division of the Appalachians.

The north-western belt of the Appalachians is a long and comparatively high table-land, called the Alleghany Mountain in Pennsylvania, the Sewell Mountain in Virginia, and the Cumberland Mountain in Tennessee. Almost the whole way continuously from north-eastern Pennsylvania to northern Alabama, it presents a high escarped slope, facing south-eastward toward the middle chain. This table-land is composed of nearly horizontal strata of the upper Devonian formations at its base, and of carboniferous rocks in its higher parts, wide tracts of it being covered exclusively by bituminous coal measures. Along its south-eastern border it is gently undulated with parallel broad regular anticlinal and synclinal flextures of the strata, the expiring waves of the middle Appalachian belt, where these crests are stronger, steeper, and more crowded. The plateau subsides to the north-west with the dying out of these flextures, and sinks into the broad plain of the basins of the Ohio and Mississippi.

A longitudinal survey of the Appalachian chain shows much undulation in its direction, and discovers ten distinct sections as respects its trend. Five of these are straight, three of them convex towards the north-west, and two of them convex towards the south-east.

C. THE ROCKY MOUNTAINS, OR CHIPPEWAYAN CHAIN.

This very elevated mountain axis, or main water-shed of the continent, consists generally of two, but in some districts of three, principal ranges, each composed of many high mountain crests, deep valleys, and elevated table-lands. The great component ranges are approximately parallel, but they are variously linked and inosculated by transverse ridges. Their crest lines undulate on a stupendous scale, and many of their summits are sharply notched and serrated like the Alps. The main eastern range rises like a huge rampart above the great table-land at its base, presenting a deeply-gashed flank and vast mountain buttresses towards the plain. Longitudinally the whole chain consists of many sections broken by deep passes, and by the cessation of the leading ridges, which, in many instances, do not join, but lap past each other. This recently ascertained feature presents unexpected facilities for the construction of railways, and other avenues of communication across the continent. In Northern Mexico the eastern range is the Cordillera of Cohahuela and Potosi, the Guadaloupe Mountains being only an outlying chain of ridges; and the western range is the Sierra de los Mimbres. Opposite the sources of the Arkansas, the eastern belt is the Moro and Chowatche, or Wet Mountain; and the western the San Juan and La Plata Mountains. The Noble valley of the Rio del Norte is here embraced between the two ranges. From the Arkansas to the north fork of the Platte, the chain is more complex

and triple; its eastern range, comprising the Medicine Mountain, contains some of the loftiest peaks of the Rocky Mountains; such are the Spanish Peaks, Pike's, Long's, and Laramie's Peaks, all rising to 10,000 and 12,000 feet above the sea. North of the Platte rise the Wind River Mountains, the loftiest division of the chain. Here Fremont's Peak has an elevation of 13,568 feet. This high mountain axis is the focal water-shed of the continent, for it parts the head fountains of the Missouri flowing to the Atlantic, from those of the Columbia and Rio Colorado, descending westward to the Pacific.

Branching southward from the Rocky Mountains, near the Wind River range, is the long and lofty chain called the Wahsatch. It is the eastern boundary of the Great Utah Desert, and the western barrier of the basin of the Rio Colorado, the Rocky Mountains being the eastern. Northward of the Wind River chain the eastern, or main axis of the Rocky Mountains, is exceedingly high, where it divides the middle and northern streams of the Columbia from the sources of the Missouri and Saskatchawan. Near the head of the latter great river, Mount Hooker towers to the height of 15,700 feet above the sea; and a little further north, Mount Brown, the feeder of the river Athabaska, reaches the yet greater altitude of 15,990 feet. From this culminating district the chain gradually declines northward to the Arctic Ocean. Beyond lat. 55° the main eastern crest ceases to be the water-shed between the Pacific and Hudson Bay, or the Arctic Ocean.

The geological constitution and structure of the Rocky Mountains are very imperfectly known. Granite and Gneissic rocks, and various palæozoic strata, including much carboniferous limestone, have, however, been extensively noticed in many districts. Between the higher ridges occur table-lands and valleys, consisting apparently of cretaceous and tertiary deposits.

(To be continued.)

Art. III.—GEOLOGICAL REPORT IN RELATION TO THE SOILS OF KENTUCKY.

Impressed with the importance of the Agricultural Department of the Geological Survey, and placing full reliance on the powers of the science of chemistry to be able to aid the Agriculturist in the most essential manner, by giving him substantial and minute knowledge in regard to the elements and causes of fertility and sterility, I have, from the commencement of the survey, paid special attention to the peculiar qualities of the various soils and their adaptation to particular crops.

In order to be able to ascertain the proportion of the different ingredients contained in the various formations, samples were collected, not only from the individual members of each group, whenever they seemed to present any peculiarity of lithological character; but in addition to this selection, I have, besides, whenever favorable circumstances presented themselves, collected soils in sets of three or four from the same locality; one, the virgin soil, taken from the original forest; one from an adjoining old field on which the same growth of timber prevailed, as in the neighboring woods from which the virgin soil was taken; also the subsoil and underclay, whenever the latter presented any characteristic qualities.

By submitting each of these separately to chemical analysis, it was confidently hoped that results would be obtained which would show, not only the distinction between the chemical composition of the soil of the various formations, and the leading lithological subdivisions, but also the exact amounts of ingredients removed from the land long under tillage by the crops annually carried off.

From time to time, as these soils were collected, they were transmitted to the chemical assistant, Dr. Robert Peter, at Lexington. That able chemist has been most assiduously engaged in the chemical analysis of these soils; some of which have already been submitted in the first report, published last year.

Since the completion of that report he has finished the analysis of forty-one more soils, sub-soils and under-clays, which will appear in the next volume, to be printed according to the 5th provision of the act providing for the Geological Survey, and laid before the Legislature at their meeting in 1857 and 1858.

On this occasion I desire to call attention to a few of the results of the chemical investigation of the soils, which I deem to be of the highest practical value, inasmuch as they not only give the land owner a complete insight into the nature of his land, but point out precisely by what means he is to bring his soil up to any required standard of fertility, as well as the most economical method of attaining this object; at the same time specifying what must be added to restore land more or less exhausted or impaired in fertility by continuous cultivation, and the removal of successive crops.

In the first instance, I shall lay before you at this time the comparative analysis of the lower blue limestone of Woodford county, on the summits giving origin to Grier's and Clear creeks, in the vicinity of Versailles, and that immediately overlying the cellular magneism limestones of Jefferson county, forming the fine, gently-rolling tracts of land lying towards the heads of Floyd's Fork of Salt river, Goose and Harrod's creeks, where those members of the upper silurian system reach the surface, as they rise in an easterly direction from beneath the coralline beds

of the falls of the Ohio river and Beargrass creek and the overlying black shales and silicious strata of the knobs, which latter formation, though not in place in the vicinity of the locality where the soil was collected, forms isolated knolls and partially denuded ridges in the southern parts of the same county, lower down on the above-named branch of Salt river.

In the following comparative table *a* is the Woodford county soil, and *b* the Jefferson county soil.

	A.	B.
Organic and volatile matter	7.771	7.996
Alumina, oxide of iron and manganese	12.961	7.480
Carbonate of lime	2.464	0.394
Magnesia	173	240
Phosphoric acid	319	205
Sulphuric acid	150	082
Potash	394	200
Soda	130	043
Sand and insoluble silicates	75.266	83.134
Loss	363	226

It will be perceived, from the foregoing comparative analysis, that the acknowledged superiority of the blue limestone soil does not depend, as is usually supposed, on its greater richness in organic matters, since, in fact, it contains 0.225 less of these principles than exist in the Jefferson county soil. This is also proved by comparison with the analysis of Fayette county blue limestone soil, given on page 277 of the first Geological Report; for in that soil the organic and volatile matters are only 004 more than in soil *b* of the above table. On the contrary, these comparative analyses, as well as many others which will be hereafter furnished in the succeeding reports, give abundant evidence that it depends on the greater proportion of *inorganic* constituents, viz: the phosphates and alkalies—although these, as may be observed, do not amount, in either soil, to a large *percentage*—together with the much larger quantity of alumina and oxide of iron, which is 5.481 per cent. more in *a* than in *b*. It is now well established that phosphates, sulphates, alkaline earths and alkalies are essential constituents of plants, and must form a part of their food; in fact, the cereals cannot come to perfection and form a nutritive grain for man or animals if the soil is destitute, or even very deficient in phosphoric acid; and though we are accustomed to view a soil proportionally rich to the larger or smaller quantity of vegetable mould it contains, yet the presence of the inorganic constituents are as essential and more difficult to restore when once exhausted, inasmuch as they cannot, like the organic, be appropriated out of the atmosphere, but must be renewed either by disintegration of the rocks which contain them, and from which they are originally derived, which must necessarily be a slow and tedious process, or by the labor and expense attendant on the transportation of guano, bone earth, and a few other varieties of manures in which

these substances are contained. Indeed, some of the earthy fixed constituents of soils, especially the alumina and oxide of iron, i. e. ferruginous clays, are important vehicles through the intervention of which ammonia is absorbed and fixed out of the atmosphere, and it is mainly from the presence of lime in the soil that nitric acid is produced—a remarkable fertilizer, either from the elements of ammonia, as evolved in the nascent state from decaying animal and vegetable matter, and perhaps, to some extent, directly from the atmosphere during thunder storms.

The quantity of inorganic fertilizers which the Woodford county soil possesses over the Jefferson county soil, in one hundred parts, are therefore:

Alumina and oxide of iron and manganese	5.481
Carbonate of lime	2.070
Phosphoric acid	0.144
Sulphuric acid	0.008
Potash	0.193
Soda	0.087
Total	7.983

The total preponderance of these fertilizers in the Woodford soil, is, therefore, a little over 1 per cent., and of some of the individual ingredients only a small fraction of one per cent.; this, at first sight, appears small and insignificant, but when calculated over a single acre of ground, only six inches in depth, the number of pounds becomes very considerable.

Assuming, as found by trial, that the average approximate weight of these air-dried soils, the proper condition used for analysis, to be about sixty pounds to the cubic foot, we obtain the following amounts in pounds, on each acre six inches deep, which the blue limestone soil of Woodford county contains over that in the soil of the eastern part of Jefferson county:

71,625 lbs. of alumina, oxide of iron and manganese;
27,050 lbs. of carbonate of lime;
1,489 lbs. of phosporic acid;
888 lbs. of sulphuric acid;
2,535 lbs. of potash;
1,136 lbs. of soda.

104,723 lbs. total.

Hence, to make the Jefferson county soil equally productive with the Woodford, for six inches in depth, there requires to be added to each acre of ground:

71,625 lbs. of ferruginous clay;
27,050 lbs. of limestone, or 15,188 lbs. of burnt lime;
3,175 lbs. of bone earth;
2,161 lbs. of gypsum;
4,848 lbs. of unleached ashes;
2,455 lbs. of common salt;

111,214 lbs. total.

In place of the 3,175 pounds of bone earth and 2,161 pounds of gypsum, there might be substituted, with advantage, 3,000 pounds of superphosphate of lime; that is, bone earth which has been treated with sulphuric acid, by which results an acid phosphate of lime and gypsum, which has been found, in practice, an excellent form of application of the highly-important inorganic constituents of soil of soils. Soda and lime are also very advantageously employed in agriculture, by dissolving common salt in as much water as is required to convert the caustic lime into a fine powder, and slaking the lime with this brine.

However, all these ingredients, except the ferruginous clay, can be obtained by the application of farm-yard manure, of which there is always more or less on every farm; but not in the manure as it is usually found, after long exposure to weather, alongside the stable, but in fresh stable and cow-house manure or in manures which have been properly preserved *under cover*, and in such a manner that neither the soluble portions have been drained away in liquid oozings from the manure pile, nor the ammonia volatilized into the atmosphere; in manure, in short, which has been carefully heaped up under shelter, in a slightly inclined plank pen, with tight floor, constructed so that all the liquid part can drain into a tank or cistern, from which it can be pumped over the manure heap from time to time, or carried separately on to the land, while, at the same time, care has been taken to fix the ammonia, which would otherwise escape into the atmosphere, either by the addition of alternate layers of much decayed wood, or other vegetable mould, charcoal powder, or, better than all, so much diluted sulphuric acid as shall prevent any odor being emitted. To such a manure pile the lime slacked with brine is also a good addition, as the sulphate of lime and chloride of calcium thereby formed are excellent absorbers of ammonia.

In the same region of Jefferson county a soil was collected from a field which had been 25 to 32 years in cultivation; also samples of the immediate subsoil and red under-clay, which almost universally underlies these lands at the depth of a few feet.

The following is the comparative analysis of the virgin soil of Jefferson *b*, while *a* is of the soil from the adjacent field long in cultivation:

In 100 parts.	A.	B.
Organic and volatile matter	7.996	4.506
Alumina oxide of iron and manganese	7.480	6.204
Carbonate of lime	394	316
Magnesia	240	200
Phosphoric acid	202	191
Sulphuric acid	082	067
Potash	200	158
Soda	043	070
Sand and insoluble silicates	88.137	88.128
Loss	0.226	00.160
	100.000	100.000

It appears from the above that there has been carried off from this field, by the succession of crops harvested, assimilation by stock filtering and washing, a part of every fertilizing ingredient except soda, in the following proportions in 100 parts:

Organic and volatile matters	3.490
Alumina, oxide of iron and manganese	1.240
Carbonate of lime	078
Magnesia	240
Phosphoric acid	014
Sulphuric acid	015
Potash	042
Total	4.919

This, calculated for one acre, six inches deep, gives:

45,607 lbs. of organic and volatile matter;
16,204 lbs. of alumina, oxide of iron and manganese;
1,019 lbs. of carbonate of lime;
522 lbs. of magnesia;
182 lbs. of phosphoric acid;
196 lbs. of sulphuric acid;
548 lbs. of potash.

64,278 lbs. total.

Here then we have the amount in pounds which would be required to be restored to each acre of this field to bring it back to its original fertility, provided the influence of cultivation has only extended to the depth of six inches; but these amounts would require to be doubled if the exhausting influence has extended to one foot.

In Europe, where the different kinds of manure, both organic and inorganic, have a commercial value, the

45,607	lbs. of organic and volatile matter would be worth	$28 50
16,204	lbs. of alumina, oxide of iron and manganese, would be worth only what it might cost to restore it, either by means of the subsoil plough or the cost of hauling it on to the land, if beyond the reach of the subsoil plough;	
1,019	lbs. of carbonate of lime, worth	63
522	lbs. of magnesia, worth	25
182	lbs. of phosphoric acid, worth	1 82
196	lbs. of sulphuric acid, worth	24
548	lbs. of potash, worth	8 22
64,278		$39 66

The importance of the information conveyed by these results is most manifest.

By far the most expensive part of the above ingredients, if required to be purchased and hauled on the ground, would be the organic constituents; but fortunately there are other economical alternatives of reclaiming the lost humus of a soil. The most abundant proximate principle of humus is vegetable fibre, which, by decay, yields chiefly carbonic acid and the elements of water. It is by supplying these to plants that it is mainly effica-

cious in agriculture. Fortunately there is an inexhaustible store of these principles in our atmosphere, and the farmer has the power, if he knows how, to appropriate them to his use from that source, without seeking further. Strange as it may at first sound, land can be *manured* from the atmosphere; that is, it can receive from it the fertilizing elements of the organic constituents of manures. But this must be effected through the intervention of the mineral, inorganic or fixed constituents of the soil; that is, those earthy principles which cannot be burnt off by fire, and are, therefore, found in the ashes of plants—such as the phosphoric and sulphuric acids, lime, clay and alkalies—for, with an abundant supply of these and ammonia, a luxuriant growth of leaves and roots overspread and penetrate the ground, having, during their growth, fixed a very large proportion of their weight and substance out of the atmosphere. It is upon this principle that the improvement of land by green cropping is based, which, when turned in, passes rapidly into a state of decay, furnishing in this way, an immediately available and abundant supply of carbonic acid, oxygen and hydrogen, in the proportions in which they exist in water; but these substances can moreover be condensed out of the atmosphere by good tillage, for the more porous and loose a soil is the more it is penetrated by air and rainwater, in which more or less carbonic acid is always condensed. Thus, if the farmer takes care that his land is sufficiently supplied with these inorganic constituents above mentioned, and a certain amount of the nitrogenous principles, he need not go to much expense in hauling humus, or its equivalent substances, mainly consisting of woody fibre, as the atmosphere has always a liberal supply on hand. Indeed the nitrogenous principles can also be obtained to a considerable extent from the same source; since there are abundant emanations continually volatilizing ammonia and carbonate of ammonia into the air, which are returned to the earth by every shower of rain or fall of snow, besides what is absorbed by a porous, well tilled soil, particularly if that soil has a notable quantity of clay and peroxide of iron.

Seeing, then, whence the organic and volatile matters of the soil may be derived, the next inquiry which presents itself in connection with the comparative analysis of the soil just given is, can any or all of the removed inorganic constituents be obtained from the subsoil or the under-clay that underlie the soil? Because, if so, this is undoubtedly the most accessible and cheapest source, whence they can be restored to the soil.

The following analyses of the immediate subsoil (*a*) and the under-clay (*b*) give the answer to this question:

	A.	B.
Organic and volatile matter	2.843	3.112
Alumina, oxide of iron and manganese . .	6.235	17.020
Carbonate of lime	356	194
Magnesia	226	

Phosphoric acid	099	477
Sulphuric acid	082	088
Potash	182	297
Soda	028	111
Sand and insoluble silicates	89.900	77.820
Loss	049	881
	100.000	100.000

The conclusion from the preceding analysis is, that they can be supplied to a *limited* extent by the immediate subsoil; but in much greater abundance by the red, ferruginous under-clay which is found universally a few feet under the soil of this part of Jefferson county. This under-clay is not only rich in alumina and peroxide of iron, uncontaminated with *pro*toxide of iron, earths which have a remarkable power of absorbing ammonia from the atmosphere, and yielding it by degrees to plants, besides retaining other manures and water, but in addition, this red under-clay, it will be observed, contains more than twice as much phosphoric acid, and nearly double the amount of alkalies which are in the virgin soil. How important is this information to the farmer; he learns by these chemical analyses that he need not go to any other source, at present, for his supply of the inorganic food of plants, and either by the aid of powerful subsoil ploughs, where this red clay is sufficiently near the surface to be reached by this operation, or where it lies too deep to be thus turned up, he can obtain it by only sinking with his pickaxe and shovel a few feet beneath the surface of his *own land*.

Let those who have hitherto had but little faith in the powers of chemistry to reveal to agriculture invaluable truths, contemplate these results.

I have heard farmers, and even those professed to be chemists, express their doubts that this science could ever disclose the mystery of vegetable assimilation, or the way in which plants received their nourishment and that transposition of the elements thereto contributing; but he who has closely watched the rapid strides of discovery in chemistry in the last quarter of a century, cannot fail to have most implicit confidence in this noble science.

Already upwards of one hundred and fifty soils have been collected in Kentucky since the commencement of the Geological Survey of the State. A large proportion of these have been selected in sets of three and four from the same locality, as has been done in Jefferson county, and are now in rapid progress of analysis, many of which will appear in the forthcoming second volume at the close of this season.

I may also state, in this place, that so far as these chemical analyses have yet been carried, they have, in every instance, been able to show not only the difference in composition of the soils from the various formations, but also the precise ingredients removed by cultivation, as well as the proportion of these.

I am not aware that such an extensive comparative investigation of the soils, on the same plan, has ever been undertaken; and I shall be greatly disappointed if there does not result therefrom most important practical results to the land-owners of this commonwealth.

I cannot close this communication, without calling the attention of the citizens of Kentucky to facts in reference to the general comparative fertility of their soil that should cause every settler to pause and reflect, before he lightly decides to leave his native State and seek a new home further west.

For the sake of comparison, Dr. Peter has made an analysis of an Illinois prairie soil collected by him in October, 1855, opposite Keokuk, a few miles back from the Mississippi river, just from under the newly-upturned original prairie sod, which I here submit:

Organic and volatile matters	3.050
Alumina	2.495
Oxide of iron	2.350
Carbonate of lime	890
Magnesia	526
Phosphoric acid	175
Sulphuric acid, not estimated	
Potash	197
Soda	100
Sand and insoluble silicates	84.470
	100.163

In communicating the results of this analysis, Dr. Peter remarks, with great justice:

"Notwithstanding the luxuriance of the growth of the first crops on the prairie soil, occasioned partly by the large amount of available nourishing matter afforded by the decay of the thick sod, it is evident, from the above analysis, that, taking into consideration *durability* as well as *immediate fertility*, as ascertained by the chemical analysis of the soil itself, apart from the soil, there are many of our Kentucky soils which take the second rank when compared with those of the *blue grass region* which yet are fully equal to this prairie soil.

"Compared with the *first-rate* soils of Kentucky, that of the prairies contains a much smaller proportion of alumina and oxide of iron, as well as lime, magnesia, phosphoric acid, and alkalies. It contains a much larger proportion of *fine* sand, and doubtless a larger proportion of the *coarser* sand, than our best soils; and, therefore, whilst its large quantity of organic matters is held in the soil with a small force of attraction, because of the large proportion which the sand and silica bears to the alumina and oxide of iron; and hence they are readily soluble, and immediately available in the production of luxuriant crops. These very circumstances will cause its most speedy exhaustion; and, when the

accumulated store of organic matter has been consumed by thriftless husbandry, this soil cannot rank beyond a second-rate position."

By a comparison of the constituents of this Illinois prairie soil with the average soils of Kentucky—for example, with *a* of the following table, which is an upland soil of Franklin county, waters of Benson, near Hardinsville, and *b*, a subcarboniferous soil of the Barren limestone formation, Barren county, we perceive that these Kentucky soils are, as a whole, in no way inferior:

	A.	B.
Organic and volatile matter	9.133	5.200
Alumina only in B; alumina including oxide of iron and manganese in A	8.100	3.460
Oxide of iron		2.206
Carbonate of lime	316	366
Carbonate of magnesia in A; magnesia alone in B	517	205
Brown oxide of manganese		234
Phosphoric acid	243	159
Sulphuric acid	668	
Potash	173	197
Soda	149	090
Sand and insoluble silicates	80.754	87.686
Loss in A; loss and sulphuric acid in B. . .	647	197
	100.000	1000.00

The Franklin county soil is even rather richer in organic and volatile matter; both are richer in argillaceous matter; the Franklin county soil is considerably richer in phosphoric acid, and the Barren county soil is almost equal to it, and contains the same amount of alkalies.

If we compare the Illinois soil with the best Kentucky soils, we find that there would require to be added to the Illinois soil, for each acre, to make it equal in the amount of fertilizers for only six inches in depth:

107,236 lbs. of ferruginous clay;
20,569 lbs. of limestone;
1,181 lbs. of phosphoric acid, or
3,802 lbs. of unleached ashes;
392 lbs. of soda, or
836 lbs. of common salt.

It is true that the Illinois soil contains 1.28 per cent. more organic matter, which would contribute to produce heavy crops for the first few years; but the above inorganic constituents are the true elements of permanent productiveness, and the Illinois soil, with 84.47 per cent. of sand and insoluble silicates, must, of necessity, be far sooner exhausted than the more intentive argillo-calcareous soil of the blue grass regions of central Kentucky.

Let not, then, the Kentucky farmer, without due consideration, leave the home of his nativity in the hope of finding in the far West land more productive than his own. Let him rather seek

to gain an insight into the qualities of his soil, and adopt a frugal method of husbanding the strength of his new land and renovating the consumed ingredients of his old.

D. D. OWEN, State Geologist.

ART. IV.—IRON ORES OF NEW JERSEY—GEOLOGICAL OCCURRENCES—PROPERTIES—METALLURGY, &c. By WILLIAM KITCHELL, State Geologist.

(Continued from page 348, Vol. VIII.)

THE following summary of the progress and present state of the iron manufacture in this country, together with the remarks upon its future prospects, is taken from a masterly paper on the "Statistics and Geography of the Production of Iron," by Abram S. Hewitt, Esq., of Trenton. It furnishes an admirable sequel to the details of the supplies and manufacture of iron which have been given in the preceding pages:

"In 1740, when the English iron trade began its wonderful career, this country was a comparative wilderness. A hardy population, scattered along the seaboard, barely succeeded in conquering for themselves the means of livelihood. The resources of the country were unknown, and no roads existed into the interior, nor was there any capital to be spared for the erection of works, from the resources of a community struggling for existence. Skilled labor was not to be found among a race who had quitted their ancient homes from a stern sense of duty at a time when operatives were proverbially ignorant and brutish. Notwithstanding these difficulties, the manufacture of iron took root; and as factories for the working of iron in the colonies were strictly forbidden by the mother country, the pig iron was chiefly exported to England, so that for the year 1771, the amount reached seven thousand five hundred and twenty-five tons. When the Revolution broke out, the country was in a condition to supply the iron required for the great work of freedom; but so little capital existed that the Continental Congress were forced to take up the business of iron-masters, and made in New Jersey, chiefly, the iron and steel required for the army.

"By the close of the war England had entered upon the f tide of success in the manufacture of iron, by the use of mine coal. Capital, skill, and labor abounded, while here all was d tress; the currency deranged by the unmanageable flood of co tinental money, and exchanges made by the rude process of ba ter. The advance of the nation from a condition of bankrupt

with its resources all undeveloped, was painfully slow; while in England, each year added to its resources, its skill, and its ability to withstand and crush competition. But the United States could be no competitor, using charcoal against mineral coal. It was not even known at the beginning of this century that we had any coal that could be rendered available for this purpose; and when our great resources in this respect began to be understood, there were no avenues to market from the coal fields. These avenues have since been constructed; but at what an enormous outlay of energy, capital, skill, and dogged resistance to obstacles of every kind, those who are familiar with the history of the Schuylkill canal, the Reading railroad, the Lehigh canal, the Delaware and Raritan, the Chesapeake and Ohio, the Delaware and Hudson, the great State works of Pennsylvania and New York, will alone be able to comprehend. The outlay for this purpose, which had to be made before the iron business could be said to have a chance of existence in this country, probably exceeded one hundred millions of dollars; and it was not until 1840, that the first furnace was successfully started and worked with anthracite coal, which in England was regarded as entirely inapplicable until 1837, when Mr. Crane first demonstrated that it could be used.

"After Crane's success, new efforts were made; and it is to be recorded to the honor of Nicholas Biddle, that he was among the first to contribute his money and his influence to the successful prosecution of the business. To another of our New York citizens, Edwin Post, Esq., who brought great intelligence, capital, and indomitable perseverance to the task, is due the honor of having first smelted successfully our rich magnetic ores with anthracite coal, at Stanhope, N. J., as he has since succeeded in reducing the franklinite, heretofore believed to be entirely refractory.

"From the time of the application of anthracite coal, the historian will date the birth of the American iron business. Its great density and purity fit it peculiarly to our rich ores; so that while in England, with three years the start of us, the product of anthracite iron had reached only one hundred and forty thousand tons in 1855, in this country it amounted to at least three hundred and sixty thousand tons; showing that, where an approach to an equality of the elementary conditions can be realized, there are lacking in this country neither energy nor skill to take advantage of the opportunity to achieve a successful result.

"The increase of capital in this country, and especially in the hands of the iron-masters, will overcome one of the artificial advantages which the English have heretofore possessed over us. At present, capital is unusually dear in England, and the course of trade, and the better knowledge abroad of our resources, are doing much to equalize the value of capital, and to remove one of the most serious difficulties in the way of the progressive growth of our domestic manufactures.

"But at the periods of low prices, the English maker does not require so much capital, because his labor is cheaper, and his iron therefore costs less.

"It is certain, however, that within the last ten years the disparity in the wages of labor in the two countries has been greatly reduced, not by any fall in the price here, but in the increase of the price in England. And it would seem reasonable to anticipate that, with the present rapid and cheap intercourse between the two continents, an equalization in the rewards of human industry would inevitably take place, and every step towards such an equality is in favor of our production of iron on terms of equality in every respect.

"It is apparent, then, that the only reason why iron *now* costs more to make in this country, is the greater value of capital and labor, and that there are natural laws at work, slowly but surely sapping at the roots of these obstacles. But it may be alleged that it will require too long a time to equalize these conditions, and that it is better to abandon the business now, and wait till these desirable changes have actually been realized. To say nothing of the ruin which this course would entail upon those who are now engaged in the business, and who have nursed it to a condition where it no longer requires the aid of any duties beyond what the revenue of the General Government demands; to say nothing of the loss of skill and machinery, which twenty years of sacrifice would not replace; I think that another natural law is at work, which will soon place us beyond the aid of tariffs or the fear of competition—a law which, overcoming the extra cost of labor and capital, insures to us that iron will be produced here at an early day as cheaply as it can possibly be got from Great Britain, even if entire free trade be allowed. If such be the fact, to discriminate against the iron trade, to deny to it the revenue duties which are imposed upon other articles of import, would be the height of folly; for the business would be ruined, and the country would save no money and vindicate no principle by such legislation.

"Let us see what this law is. I have been at great pains to trace the increase of the consumption of iron by the world, and to form an accurate idea of its future demands. I have called your attention to the fact that, even now, the resources of Great Britain have been so taxed to meet the existing demand, as to increase *the cost* of iron, (I do not mean the price,) because the miners are driven to less favorable localities to procure adequate supplies of raw material. If the production of three and a-half millions of tons per annum has made each ton cost more than it did when the production was only two millions, the addition of another million must have a corresponding effect. But the world will want, and must have the other million, and two of them, and three of them, and, unless other countries aid in the supply,

the price will rise far above our present cost of production. It seems to be the inevitable conclusion of the facts I have stated, that this day is not far distant. Even now, we can make iron at the *average price* of English iron, and if we make none, that average price would be higher; so that there is no reason to believe that iron would be sold for less than it now is, if it all came from England. But let it be noted that the American iron-master now asks for no special legislation in his behalf; but he objects to any legislation, and very properly, which excepts him from whatever incidental advantage there may be in the fair imposition of duties for revenue. Heretofore, in times of great depression, long continued, he has felt the want of financial or legislative corks to float him over these "sloughs of despond," and it is at such times, and such times only, that you have heard him, a drowning man, conscious that he has many years of life in him, if he could only touch a buoy for a short period, calling on Congress for temporary relief, or entreating that the slight prop between him and ruin might not be knocked away. Now, however, he feels that the steadily-increasing demand of the world for iron, and the fact that England cannot supply the whole of it without a decided increase in cost, insures to him that soon, aside from the question of capital and labor, these periods of extreme depression will either cease to occur, or if recurring at all, will continue for such short intervals that he can sustain himself till the improvement takes place.

"I have been thus careful to show that this day the possession of adequate skill, of extensive and properly-constructed works, of a large body of intelligent workmen, of great natural resources in the way of raw materials and channels of communication, and of equally great ones in the canals and railways which the genius of our age and people has constructed, makes legislation for the purposes of protection no longer necessary, because I regard the days of protection, for the sake of protection, as passed away. I have been equally careful to show that the artificial elements of dearer labor and capital do not make us independent of a fair share of those duties which are necessarily imp sed for the raising of national revenue, but that there are causes at work which promise soon to make us independent even of this aid, to which we have a fair claim in the balance of national interests; because, under this state of fact, intelligent and influential men, identified with our great railway interests, have combined together in the short-sighted policy of demanding a remission of the duties on railroad iron at a time when it has been demonstrated, and is admitted by all experienced engineers, that our American rails are more durable than the foreign rails, and, consequently, worth more by the whole amount of duty paid. They have made this movement at the very time when the facts and probabilities all favor the conviction that the steady approach to

From the oxygen ratio of this it appears that the phosphoric acid and lime exist in the proportion of $3CaOPO_5$. The crucible, after ignition, showed indications that chloride of iron had been volatilized.

Below this exterior crust the rock has a varied appearance; it is of a dark brown color, in places quite black, varying in others to a lighter shade, in which portion are frequent cavities filled with minute crystals of gypsum, readily recognizable with a pocket lens. The darkest portion is the most solid, with a slightly vitreous lustre, and of a much greater tensibility and hardness than any other portion of the guano; it has a sub-concoidal fracture, sometimes splitting into thin fragments, which are translucent; through some portions of it I have observed frequently, thin irregular bands, 1-32d to 1-16th of an inch in width, which has the appearance of carbon.

This portion was selected for analysis with particular care, with the view to ascertain its exact composition; it was with difficulty reduced to the finest powder and treated with distilled water (in the cold) in a beaker glass, being frequently stirred for several days in order that the water should be in frequent contact with the particles; it was then collected on a weighed filter and washed with cold water until the filtrate showed no trace of sulphuric acid; the excess of filtrate was evaporated to dryness, and a thorough analysis made of it, the result of which is the following:—

(II.)

3.9922	grammes	0.3836	grams.	BaO, SO_3	gave	Sulphuric acid,	3.30
"	"	0.1761	"	$CaOCO_2$	"	Lime,	2.48
"	"	0.0099	"	Ag	"	Chlorine,	0.08
"	"	0.0531	"	$2MgO, PO_5$	"	Phosphoric acid,	0.35
"	"	0.0089	"	Na Cl	"	Soda,	0.88

Per centage	Sulphuric acid,	3.30	Oxygen ratio,		1.97
"	Phosphoric acid,	0.85	"		0.54
"	Lime,	2.48	"		0.70
"	Soda,	0.88	"		0.22
"	Chlorine,	0.08	"		

There was in this analysis a loss of lime or Magnesia, also, of the insoluble residue.

Selections were made from other specimens which resembled very nearly that above described; it was treated in the same manner as (II.), but the results show a marked difference, there being a smaller percentage of phosphate of lime dissolved from (II.) than from (III.) and a proportional amount of chloride of sodium. To this fact I shall again refer.

The following is the result of analysis:—

(III.)

The residue before weighing was carefully dried at 100° C.

2.7271	grammes left, residue of	2.3177	gram.			84.98
"	"	0.0095	grams.	Ag	gave Chlorine,	0.11
"	"	0.3603	"	BaO, SO_3	" Sulphuric acid,	4.91
"	"	0.2536	"	CaO, SO_3	" Lime,	3.84
"	"	0.0083	"	$2MgO, PO_5$	" Magnesia,	0.11
"	"	0.0600	"	$2MgO, PO_5$	" Phosphoric acid,	1.58
"	"	0.0201	"	Na Cl	" Soda,	0.40

Chlorine,	0.11 per cent.	Oxygen ratio,	
Sulphuric acid,	4.91 "	"	2.94
Phosphoric acid,	1.58 "	"	0.88
Lime,	3.84 "	"	1.09
Magnesia,	0.11 "	"	0.04
Soda,	0.40 "	"	0.10

From another portion of the rock the black portion was selected for analysis, the quantity of sulphate of lime is very inconstant. The results of analyses were as follows:—

(IV.)

0.9170	grammes,	.0536	gram.	BaO, SO_3	gave Sulphuric acid,	2.01 per ct.
"	"	0.0510	"	CaO, CO_2	" Lime,	3.13 "
"	"	0.1532	"	Fe_2O_3	" Sexquioxide of iron,	16.71 "
"	"	0.1123	"	Al_2O_3	" Alumina,	12.25 "
2.0741	grams.	lost by heating,		0.3254		15.69 "
"	"	insoluble residue,		0.1314		6.13 "

Owing to an accident to the platinum crucible just before weighing, the phosphoric acid was not determined.

Sulphuric acid,	2.01 per cent.	Oxygen ratio,	1.20
Lime,	3.13 "	"	0.89
Sesquioxide of iron,	16.71 "	"	5.00
Alumina,	12.25 "	"	5.70

The specimens from which the material for the above analyses were selected, I received from Messrs. Richards & Miller, agents for the Philadelphia Guano Company; there is doubt as to their exact locality; in appearance they correspond exactly with that from Monk's Island, but the results of the analyses are very different from those obtained from the specimens from this island which I received from Dr. Luther.

That alumina is present as a phosphate, in the guano from Monk's Island, I have proved, by treating 3.4023 grammes of an average sample of the cargo of schr. Trident from Monk's Island, with pure caustic potash in a silver dish, and was found to contain 1.52 per cent. of alumina.

Specimens were given me from Monk's Island by Dr. Luther, the characteristic appearance of which has already been described.

1.5915 grammes were treated in a silver dish with potash, but not a trace of alumina could be detected; the residue dissolved in hydrochloric acid was found to contain lime, 39.08 per cent.

The guano rock from Monk's Island, when finely powdered

and treated with distilled water, gave an acid reaction with litmus paper.

(V.)

1.7076 grammes (organic matter and water not determined).

"	"	0.1993 gram.	BaO, SO_3	gave Sulphuric acid,	4.00	per cent.
"	"	0.0780 "	$2MgO, PO_5$	" Magnesia,	1.64	"
"	"	1.1999 "	CaO, CO_2	" Lime,	39.34	"
"	"	1.1461 "	$2MgO, PO_5$	" Phosphoric acid,	42.98	"

Sulphuric acid,	4.00 per cent.	Oxygen ratio,	2.39
Magnesia,	1.64 "	"	0.65
Lime,	39.34 "	"	11.10
Phosphoric acid,	42.98 "	"	24.09

For the oxygen of the sulphuric acid 2.39 there are required, 0.88 of the oxygen of the lime, and if to the remainder be added the oxygen of the magnesia we have 10.95, which is to the oxygen of the phosphoric acid very nearly as 1 : 2.

(VI.)

2.8678 grammes treated with distilled water gave:

"	"	2.7076 grams.	residue,		94.41	per cent,
"	"	0.1287 "	BaO, SO_3	gave Sulphuric acid,	1.49	"
"	"	0.0655 "	CaO, CO_2	" Lime,	1.27	"
"	"	0.0363 "	$2MgO, PO_5$	" Phosphoric acid,	0.81	"
2.8426	"	treated with distilled water gave:				
"	"	0.0076 grams.	Ag	gave Chlorine,	0.09	"
"	"	0.0347 "	$2MgO, PO_5$	" Phosphoric acid,	0.78	"
"	"	0.1099 "	BaO, SO_3	" Sulphuric acid,	1.33	"

Lime,	1.27 per cent.	Oxygen ratio,	0.36
Phosphoric acid,	0.81 "	"	0.45
Sulphuric acid,	1.49 "	"	0.89

Guano rock has been brought from another group of islands called Centinella, consisting of peaks, which sometimes attain a height of 800 feet. The rock is described as consisting of two layers, the upper of which is a dark-brown compact rock, varying slightly from the lower layer. This so-called lower layer has certainly a surface exposed, as the specimen which I have examined has been much weathered; the outer portion is partially reniform, which in places shows a slight enamel, though not near as distinct as on the specimens from Monk's and El Roque islands. It has evidently been formed in layers, which, when broken across, show a slightly-banded appearance not unlike that already described as characteristic of portions of the rock from Monk's Island; the color varies from a buff to an ochreous brown; it is hard, brittle, and much more readily pulverized than the Monk's Island guano rock. An opinion may seem premature, but I am inclined to the belief that this has once been as the guano rock from Monk's Island, which has undergone changes from causes not yet fully studied, which seems more probable from the fact that small quantities of phosphate of alumina have been found in the Monk's Island rock.

The whitest portion of the rock was selected for analysis, which gave the following results:—

(VII.)

1.5165 grams.	ignited gave	.3469 grams.			22.87	per ct.
" "	0.2000 grams.	insoluble matter,	Silicia,		13.18	"
" "	0.0474 "	BaO, SO_3	gave	Sulphuric acid,	1.07	"
" "	0.6921 "	$2MgO, PO_5$	"	Phosphoric acid,	29.23	"
" "	0.0720 "	CaO, CO_2	"	Lime,	2.66	"
1.3048 "	0.2120 "	Al_2O_3	"	Alumina,	16.24	"
" "	0.1628 "	Fe_2O_3	"	Sesquioxide of iron,	12.41	"
" "	0.6438 "	$2MgO, PO_5$	"	Phosphoric acid,	31.60	"
" "	0.0660 "	CaO, CO_2	"	Lime,	2.83	"
" "	0.0057 "	$2Al_2O_3, 3PO_5$	"	Phosphate of Alumina,	0.43	"

Water?	22,87 per cent.	Oxygen ratio,	21.54
Silica,	13.18 "	"	6.84
Sulphuric acid,	1.07 "	"	0.65
Phosphoric acid,	31.60 "	"	20.24
Lime,	2.66 "	"	0.75
Alumina,	16.24 "	"	7.59
Sesquioxide of iron,	12.41 "	"	3.61

The 0.65 of oxygen of the sulphuric acid requires 0.22 of the oxygen of the lime, the remaining lime is most likely combined with carbonic acid, as nearly every specimen on treating with dilute acid gave a slight effervescence, (the guano rock from the vertical cliff contained nearly one per cent.,) or possibly a remnant of the once phosphate of lime still exists. The alumina and phosphoric acid exist most likely in the form of Wavellite, which has the formula $3Al_2O_3, 2PO_5+12HO$. It is difficult in a rock which is in progress of decomposition, to obtain other than approximate formulæ.

This island of Centinella is now inhabited by immense numbers of water-fowl, many of which roost on the cliffs; some of these roosts have been long occupied, and judging from the signs on the rocks beneath, have been much resorted to. Mr. Richards of this city, who visited the islands a short time since, broke off a portion of the concretion which cover the cliffs beneath a bird roost of this description; the organic properties had mostly been removed by causes which had converted the inorganic constituents into a guano rock, which in its composition is not unlike that from Monk's Island and El Roque. Mr. Richards mentioned that when first obtained it had quite a strong odor, which has now almost disappeared; it is very hard and was difficult to powder.

The analysis of the concretion is as follows:—

(VIII.)

2.0904 grams.	on ignition lost	0.2361 gram.			11.29	per ct.
2.2904 "	0.0248 grams.	Al_2O_3	gave	Alumina,	1.08	"
.8470 "	0.066 "	BaO, SO_3	"	Sulphuric acid,	2.67	"
" "	0.4707 "	CaO, CO_2	"	Lime,	31.18	"
" "	0.0406 "	$2MgO, PO_5$	"	Magnesia,	1.74	"
" "	0.0143 "	Fe_2O_3 & Al_2O_3	"	Iron and Alumina,	1.69	"
" "	0.0506 "	insoluble,	"	Silica,	5.97	"
1.8570 "	1.0153 "	CaO, CO_2	"	Lime,	30.68	"
" "	0.0926 "	$2MgO, PO_5$	"	Magnesia	1.79	"
" "	0.0346 "	Fe_2O_3 Al_2O_3	"	Alumina and Iron,	1.86	"
" "	1.2520 "	$2MgO, PO_5$	"	Phosphoric acid,	41.89	"
1.2142 "	contained	0.0089 grams. CO_2	"	Carbonic acid,	0.73	"

Alumina and Iron,	1.86 per cent.	Oxygen ratio,	0.86
Sulphuric acid,	2.67 "	"	1.59
Carbonic acid,	0.73 "	"	0.54
Lime,	31.18 "	"	8.86
Magnesia,	1.74 "	"	0.69
Phosphoric acid,	41.89 "	"	23.25

1.59 oxygen of sulphuric acid require 0.53 of oxygen of the lime; 0.53 of oxygen of the carbonic acid require 0.27 oxygen of the lime, but if there is added to this remainder the oxygen of the magnesia there remains 8.75 oxygen of lime, which is to the oxygen of phosphoric acid 23.25, about in the ratio of 1 : 2, particularly as the oxygen of the alumina requires oxygen of the phosphoric acid, to form a salt with a formula most probably corresponding to that of wavellite, as before mentioned.

Mr. Richards brought with him also a specimen of the recent alluvial guano, or bird excrement, as it may be justly termed; he obtained it from a little nook in the rocks, where it was protected from the intense dry heat of the sun and from the action of water. Mixed through it were several birds' feathers. As may readily be imagined it had some odor, though not excessively strong.

7.4921 grams. were ignited in a platinum crucible, and gave a very strong and disagreeable odor like burning hair; it was moistened with carbonate of ammonia and again gently heated, and gave a loss of 4.0032 grams.=53.83 per ct.

(IX.)

2.1975	grams of the ash showed a trace of Alumina.					
"	"	0.2746	grams. BaO, SO_3	gave	Sulphuric acid	4.29
2.236	"	1.5150	" CaO, CO_2	"	Lime	38.02
"	"	0.0913	" Sand	"		4.83
4.0704	"	ignited gave a loss 1.9171 gram.				47.10
1.9997	"	Ash				
"	"	1.3858	grams. CaO, CO_2	gave	Lime	38.89
"	"	0.2206	" BaO, SO_3	"	Sulphuric acid	3.79
"	"	0.2100	" $2MgO, PO_5$	"	Magnesia	3.77
"	"	1.3178	" $2MgO, PO_5$	"	Phosphoric acid	42.21
"	"	0.0225	" Sand	"		3.25
"	"	0.0164	" Ag	"	Chlorine	0.26
3.9652	"	loss by ignition 1.9282 gram.				48.62
.9857	"	0.6892	grams. CaO, Co_2	gave	Lime	39.12
.9794	"	0.0085	" CO_2	"	Carbonic acid	0.86
"	"	0.1250	" BaO, SO_3	"	Sulphuric acid	4.28

Lime,	38.89 per cent.	Oxygen ratio,	11.05
Phosphoric acid,	42.21 "	"	23.65
Sulphuric acid,	4.29 "	"	2.57
Magnesia,	3.77 "	"	1.50

2.57 oxygen in sulphuric acid require 0.85 oxygen in lime; there remains 10.19 oxygen of lime, which, if added to the oxygen of the magnesia, makes 11.69, which stands with the oxygen of the phosphoric acid 23.65, near the ratio $2CaO, PO_5$.

A guano rock has recently been brought from a group of islands called El Roque, in the Caribbean Sea. In composition it resembles very closely that brought from Monk's Island; the

specimens that I have analyzed contain, however, a much larger quantity of sulphuric acid than has been found in the latter rock. The appearance of the body of the two rocks is also much alike, but in the specimens which I have seen from El Roque the exterior crust is very different; it is rarely more than a slight coating; in some places it has a slight appearance of the enamel, when examined with a pocket lens; the surface is very irregular, often containing cavities which are lined with the same white coating. It was impossible to obtain sufficient of this for analysis; the analysis of the black portion of the rock was as follows:

(X.)

1.8636 grms.	loss by ignition	0.1904 grms.	water and organic matter	10.22	per ct.
1.4609 "	0.3274 grams.	BaO, SO_3	gave	Sulphuric acid,	7.70	"
" "	1.0066 "	CaO, CO_2	"	Lime,	38.67	"
" "	0.1118 "	$2MgO, PO_5$	"	Magnesia,	2.75	"
" "	0.0116 "	Insoluble	"		0.78	"
" "	0.0058 "	Fe_2O_3 & Al_2O_3		Iron and Alumina,	0.40	"
1.1680 "	0.7936 "	CaO, CO_2	gave	Lime,	38.12	"
" "	0.0879 "	$2MgO, PO_5$	"	Magnesia,	2.70	"
" "	0.7383 "	$2MgO, PO_5$	"	Phosphoric acid,	40.49	"

Organic matter and water, 10.22 per cent.			
Sulphuric acid,	7.70	Oxygen ratio,	4.61
Lime,	38.67	"	10.09
Magnesia,	2.75	"	1.09
Phosphoric acid,	40.49	"	25.93
Alumina and Sesquioxide of Iron,	0.40	"	
Insoluble,	0.78		

4.61 oxygen in sulphuric acid require 1.54 oxygen in lime; therefore remains 8.55 oxygen in lime which stands with the oxygen of phosphoric acid 25.93 in the ratio 1:3, showing that the phosphate in this specimen consists principally of $3CaO\ PO_5$.

A specimen containing no organic matter was examined from Testigoe Island, but the rock was very much disintegrated; it was very porous, and evidently had been acted upon by some causes which were gradually removing all its components except the silica. In appearance it was largely a sandstone, as the analysis showed. The most compact portion of the specimen was selected, which was readily pulverized; the results of the analysis differ from all the other specimens. The following are the results:

(XI.)

1.2910 grams.	insoluble Silica 0.6722 grams.			52.07	per cent.
"	0.0085	CaO, CO_2	gave	Lime, 0.37	"
"	0.0206	$2MgO$	"	Magnesia, 0.57	"
0.8806 grams.	0.1073	loss by ignition		Water 12.17	"
0.8806 "	insoluble	0.4600 grams.		Silica 52.27	"
				Sulphuric acid trace.	
"	0.1158	$Al2O_3$	" gave	Alumina 13.03	"
"	$2Fe_2O_3\ 3PO_5$	0.0318	" "	Phosp. of Iron 3.61	"
"	$2MgO, PO_5$	0.2394	" "	Phosp. acid 17.41	"

Silica,	52.07 per cent.		
Lime,	0.87 "		
Magnesia,	0.57 "		
Water,	12.17 "	Oxygen ratio,	10.81
Sulphuric acid trace.			
Alumina,	13.03 "		6.12
Phosphate of iron,	3.61 "		
Phosphoric acid,	17.41 "		9.81

The alumina and phosphoric acid seem in this to be in the form of wavellite.

The guano rock from the various groups of islands has very varying composition, as has been seen from the foregoing investigations; it is found in layers, and the surface sometimes covered with an alluvial deposit; these layers are in places highly inclined, showing that since their deposition dynamic causes have altered their original position. This same phenomenon is described as occurring at the Chincha Islands in the Peruvian guano, where it is found in layers two or three yards in thickness. Various theories have been formed and published as to the origin of the rock guano; these are doubtless premature, as the accounts as to its occurrence are founded on reports of those not accustomed to noting geological phenomenon.

Prof. C. U. Shepard has, with his characteristic energy, extended his mineralogical species to various portions of this rock, which he severally describes* and designates generally as pyroguanite minerals, and entirely destitute of ammonia; but examinations made of an average sample of a cargo from Monk's Island showed one-half per cent. of nitrogen. Every specimen which I have examined, has an ignition giving very marked evidence of burning organic matter. How this can be retained in a rock subjected to the agency of heated trap is as difficult to reconcile, as that the composition of minerals existing with and forming a part of its mass, as Prof. Shepard describes,* containing water in their composition. Moreover, how can a rock subjected to the agency of heated trap have its principal basis a salt with the formula $2CaO, HO, PO_5$ which is the formula ascribed to it by Drs. Piggot and Beckell, of Baltimore, and which seems to be the proper composition of some portions, as shown by analysis of Monk's Island rock (V.), though in the analysis of the specimen from El Roque (X.) there is obtained the formula, $3CaO\ PO_5$.

As I have already mentioned, this guano rock from *Los Monges* has been called a native super-phosphate of lime, but no satisfactory proofs are given as to its meriting such a name; phosphoric acid being found in solution after the guano is treated with water, is no proof that it exists in a free state. Phosphate of lime, when recently precipitated, is soluble to a slight extent in

* Am. J. Sci. 12, xxii. 96.

pure water (R. Phillips, Ann. Phil. 22,188). Berzelius long since discovered phosphates of lime and alumina in the water and deposits of hot springs at Carlsbad.* That phosphates are insoluble and must be rendered free before becoming efficacious as fertilizers is an erroneous, though a very prevalent opinion. According to Brischof† phosphate of lime must be regarded as present in all water running into the sea; it has already been detected in the waters of the Dee and of the Don, and it will most likely be found in the waters of all rivers. Phosphate of lime and magnesia have also been found in the waters of an artesian well at Wildegg, in the Canton Argan (Switzerland). Phosphate of lime has been shown to be present in sea water by Clemm‡ and by Forchammer.§ According to Berzelius it is the *di*-phosphate which is found in mineral waters,‖ which is readily soluble in water saturated with carbonic acid. The basic-phosphate of lime is also readily soluble in water containing carbonic acid; Bischof gives a very interesting table of the degrees of solubility of the various basic-phosphates of lime in water saturated with carbonic acid gas.¶

It is not only in carbonic acid waters that phosphate of lime is soluble; basic-phosphate of lime dissolves in 3.150 parts of water, containing one-twelfth by weight of chloride of sodium. The presence of chloride of ammonium increases the solubility still more.¶

It is probable, therefore, that the solubility of the phosphate of lime guano rock from Los Monges is owing to the presence of the chloride of sodium existing in it. By reference to the analyses (II. and III.), it will be seen that the phosphate of lime dissolved is in proportion to the chloride of sodium in the specimens. This will, however, require more detailed examination.

Though the rock from Centinella containing so large a percentage of phosphoric acid combined with iron and alumina may seem at first worthless as a fertilizer, no positive opinion should be formed or expressed without a very careful investigation of the subject, which I believe has never yet been made. It is true that phosphate of alumina is one of the most sparingly soluble substances known, though it is soluble in water saturated with carbonic acid, according to Bischof in about 6.828.000 parts, though in the water of the Carlsbad springs about double this quantity is held in solution, viz.: $\frac{1}{3.125000}$.**

Though the phosphate of lime is applied to soils, and, as such, taken up by plants, there is no proof that it remains in that form

* Gilbert's Annalen, lxxiv. 136.
† Chem. and Phys. Geology, vol. 2, p. 27 (Engl. edit.).
‡ Journ. fürprakt. Chemie xxxiv. 185.
§ Berzelius, Jahresbericht xxvi. 393.
‖ Gmelin, vol. iii. p. 195.
¶ Chem. and Phys. Geology, vol. ii. p. 28.
** I bid. p. 34.

until the plants have need of it; it enters into new combinations, some of which may be quite as insoluble as this Centinella rock. The phosphate of lime dissolved by the carbonated waters always found more or less in soils, * is decomposed by alkaline carbonates; the lime would therefore be converted into a carbonate, and a phosphate of the alkali will be formed.† Bousingault and Levy, Journ. des Debats, Dec. 5, 1852, found that the air in the interstices of arable soils contained as much as 22 to 23 times as much carbonic acid as the atmosphere, and when the soil has been recently moistened 245 times as much. Phosphate of lime lying in such a soil would be dissolved in a comparatively short space of time.

Carbonate of iron is present more or less in every soil, and consequently if in a soil the carbonate of iron and phosphate of lime exist, both held in solution by a carbonate of the alkalies, a mutual decomposition may take place,‡ consequently we may have vivianite formed in the soil; instances are frequent of vivianite in fossils of the green sand of New Jersey,§ but geological ages are not required to produce these changes. M. Jerome Nickles has recognized its presence in human bones, (Amer. Jour. of Sci. vol. xxi. p. 402.) He found in a cemetery at Eumon, a village in the department of La Meurthe, the earth of which was very ferruginous, two arm bones of a female, a cubitus and a radius, having a deep bluish green color. On breaking, the alteration was found to be complete, and a qualitative chemical examination proved it to be phosphate of iron. It is to be regretted that a quantitative analysis was not made, to have determined whether all the bone phosphate had been decomposed and the transformation into phosphate of iron complete. M. Nickles, on examining the medullary cavity with a lens, found among the sinuosities left by the hardened marrow brilliant points which were distinctly crystals of vivianite. The bones were in a perfect state of preservation, and afforded, when treated with hydrochloric acid, a skeleton of gelatine, proving that gelatine does not resist the absorption of the ferruginous compound.

* Researches that have been made by Lassaigne, Jour. Chim. Med. 3 ser. iv. 354; and Ann. de Chim. et. de Phys. 3 ser. xxv. 346, show that phosphate of lime is conveyed into the plant's organism by water saturated with carbonic acid. Dumas (Comptes Rendus, xxiii. 1018) holds the same opinion.

† Bischof, Chem. and Phys. Geology, vol. i. p. 13, No. 19. Phosphate of lime dissolved in carbonated water forms Carbonate of Lime, which is precipitated, and alkaline phosphate which remain in solution.

‡ Phosphate of lime dissolved in carbonated waters and proto-carbonate of iron form a proto-phosphate of iron, which is precipitated, and bi-carbonate of lime which remains in solution. (Bischof vol. i. p. 13, No. 20.)

§ In the green sand of New Jersey, the decomposition is not owing probably to the carbonate of iron, but to the sulphate resulting from oxidation of the iron pyrites. (Bischof, vol. i. p. 14, No. 21.) Phosphate of iron and proto-sulphate of iron form sulphate of lime and proto-phosphate of iron. Similar changes probably result in this guano rock, as in many specimens we find crystals of gypsum recognizable with a pocket-lens.

Various theories have been formed and published as to the origin of the rock guano; these are most likely premature, as the accounts as to its occurrence are founded on reports of those not accustomed to noting geological phenomena. The continued and gradual upheaval of islands in the ocean and their depression is a well-established geological fact.

The islands of the Caribbean sea are very varied, some are quite low and covered with sand composed of fragments of shells, madrepore and corals, which can readily be distinguished with a pocket lens. These sands are resorted to by myriads of water fowls for laying their eggs. One of the captains who visited there mentions, that it is necessary to make one's way through them with a stick. Other islands attain heights of 800 feet; it seems improbable that such heights could be created by accretions of guano and sand, when the islands were subject to a continued action of the waves of the ocean. The inclination and irregularity of the guano layers render it not improbable that the dynamic causes which produced this distortion, elevated at the same time the islands.

It is most probable that the guano rock from some of the islands has been changed in its composition by reactions of the salts contained in sea water, but before such reactions can be fully explained, accurate analyses must be made of this sea water.

It is a remarkable fact, that the composition of the ash from the recent guano from the heights of the Centinella rock composed of phosphates of alumina and iron, should have a composition so very near to that of the guano rock from the Los Monges and El Roque Islands.

The frequent occurrence of alumina and iron is to be remarked in the guano rocks.

The upheaval and subsidence of land is caused not only by earthquakes, (Lyell's Principles of Geology, 8th edit. chap. xxxi.,) but by other changes, such as are in progress in Sweden and Norway, and in Greenland. The upheaval of islands in the Caribbean Sea may most likely be ascribed to volcanic action, some of these are within 150 miles from Gaudaloupe. (Lyell's Principles, 336.) Von Buch inclined to the belief, that the volcanic chain of the Andes was connected with that of the West India or Caribbean Islands. The truth of this conjecture has been almost set at rest by the eruption of the volcano at Zamba, in New Grenada, at the mouth of the river Madalena.*

The vicinity of the volcanoes may give additional salts to the sea water.

NOTE.—I have just been informed by Dr. Luther, that from analyses lately made in Baltimore of a cargo of rock guano, that has lately arrived from the island of Testigoes, there has been found from forty to forty-five per cent. of phosphoric acid.

* Comptes Rendus, 1849, vol. xxix. p. 531.

Art. VI.—A SKETCH OF THE GEOLOGY OF TENNESSEE. COAL: By R. O. Currey, M. D., Knoxville, Tenn.

(Continued from page 243, vol. viii.)

Geological position of the Coal Deposits.—This formation is composed of alternating series of argillaceous shales, micaceous sandstones, and coal. They occur above the rocks of the transition, or silurian period. On the one side, the fossil ferns of the coal strata are lined with the trilobite, the euomphalus, and the extensive family of the crinoidea; and on the other, with the remains of the gigantic saurians—and their foot-prints impressed on the new red sandstone.

The characteristic fossils of the coal measures are fossil plants; such as stigmaria, sigillaria, lepidodendron, calamites, with many species of ferns—all beautifully impressed on the clays and shales, and sometimes even the coal itself has presented the fibrous character of the wood. In the midst of the dense and majestic fern forest, as it originally grew and flourished, the only reptiles whose remains have as yet been discovered, the *cheirotherium* and *apateon*, stalked sole lords of their forest home.

Utility of Coal.—On this subject I introduce a few extracts from a report made by Charles Ellet, Esq., President, to the Schuylkill Navigation Company:—

"This is essentially the age of commerce and of steam—the foundation of which is our *coal mines*.

"Each railway requires iron for its track, engines, cars, and frequently for its stations. Each new steamer requires coal to drive it—iron for its engine, and sometimes for its hull; and five tons of *coal* for each ton of iron it consumes.

"The manufacture of the iron, and the propulsion of the machinery, require *coal;* the quantity increases with the expansion of the railway system; the system extends the area of civilized population, and consequent agricultural wealth. This wealth needs transportation, and this transportation again needs coal and iron."

And as another report remarks:

"Mineral and metallurgic industry is, with agriculture, the most vital element of our country's prosperity. Coal is the most essential agent of all industry; the foundry, the iron, constitute merely the instruments, the elements of riches."

Palæontology of the Coal Measures.—This department of geology has not been developed to a sufficient extent in Tennessee to afford us a complete view of the fossil remains found entombed within it. But whether examined in the United States, in Europe, or in Asia, these measures have always been found to contain the same classes and species of fossils; so that it is presumable that many more than have as yet been discovered, lie imprinted beneath the strata as on a page—the unread history of another epoch.

No one, at the present day, doubts the vegetable origin of

coal. Its geological position; its chemical composition; its organic remains, each affords evidence of this fact. Sometimes entire beds of coal are composed of small leaves; and at others the trunks of trees are turned up in a carbonized state. Some varieties of coal on the fresh fracture present the appearance of charred wood, possessing a glossy, soft and fibrous texture.

The character of the extinct flora indicates a vegetation that belongs to a tropical climate—and that delights in low, swampy localities; the corresponding species to be found at present in our temperate latitude being of stinted growth, and rather herbaceous than arborescent.

During some powerful convulsion of nature, these gigantic forests were suddenly engulphed or entombed, and the process of carbonizing went on gradually for ages, till, in the course of time, as in our coal field, another of those revolutions which have marked the surface of our planet, elevated our Appalachian chain of mountains, the waters drained off, and left, far out on land, this immense deposit of a mineral, adapted to the wants, that were to be, of man—the last act of creative agency.

Thus prepared, these carbonized masses of the remains of earth's primeval forests are, by the development of art and science, once more unlocked, and made to perform a part anew in the economy of nature. The elements of their composition are disengaged to illuminate the crowded city, and employed in thousands of operations devised by the ingenuity of man. The characters of the plants of which it is composed, are read in the leaves and in the fruit, in the trunks and in the roots which have escaped destruction during the process of carbonization. And the remains of the only two animals which are as yet known to have enjoyed the grandeur of this primeval scenery, are traced out in their tracks and in their fossils—the mute interpreters of things as they once existed.

The fact that there are found successive layers of coal, clay, and sandstones, may be accounted for on the principle of what we see going on in the deltas of our rivers, and in our alluvial deposits, that of the rising and falling of the waters, and the periodic accumulation of drift. According to this, those parts of the plant which could float would be found at the uppermost part of each layer, while the heavy and water-logged trunks, perhaps still attached by their roots, would carbonize in the lower strata—in short, would constitute the coal itself. And such is found to be the case. The argillaceous slates are, in every seam, imprinted with the leaves and fruit and stems of the flora, while lower down the trunks and lower parts are imbedded, in some instances, in the coal itself.

The leaves of several species have been found, together with the roots, trunks and stems of others. Suffice it in this sketch merely to designate these without any special description or classification.

Of leaves we have, belonging to the ferns, the *pecopteris* and the *sphenopteris*, the stems of the *calamites*, the stems of the *sigillarias*, and their roots the *stigmarias*, the *lepidodendron*, and the *asterophyllites*, (the star-like fern,) besides stems and leaves of the *coniferæ*.

So regularly and distinctly are these fossil flora imprinted on the fine-grained slates that they appear as the work of art; they are, in fact, nature's lithographs.

Middle Tennessee.—The geological observer, as he passes in his explorations over each successive stratum composing the various formations of a district, has at his command at least three characteristics by which the different strata, especially when interrupted by mountains or ravines, may be classified and referred to a common origin. These characteristics relate to the chemical constituents of the rock strata, their relative position, and the organic remains or fossils imbedded in them. He experiences no difficulty in forming a conclusion by the application of the first two tests; but in order to satisfy himself of the correctness of that conclusion, he must thoroughly read the history imprinted on that rock by the animals which existed at the period of its deposition. These three tests, therefore, enable him in a scientific manner to group together the rocks of a district in established formations. We have so far in our sketch had but little to say concerning this mute language of our geological formations, though the field over which we last passed was, in this respect, of no ordinary interest.

I pass now to the consideration of a new field, differing in the position of its strata, as well as in their characters, from those in East Tennessee, and in the coal measures; not so rich, however, in *mineral* resources, yet embracing within its limits abundant materials for individual enterprise. Here, too, the fossils of these middle counties, lying between the *base* of the Cumberland mountains and the Tennessee river, so numerous and so varied, render this as classic ground for the naturalist.

The traveller, on descending from the heights of the Cumberland mountains, the carboniferous formation of our State, finds, as he continues his journey towards the city of Nashville, a series of rock strata, each successive one being so much lower than the others. These strata are also found to differ in several other respects. If, then, he should pass beyond this point in any other direction, North, South, or West, he notices that he gradually ascends in like manner until he reaches the high lands, of a similar character to those at the base of the mountains.

The conclusion naturally forces itself upon his mind, that Nashville is lower than the surrounding country. This is true in a geological, though not altogether in a topographical, point of view.

I will therefore take the city Nashville as a starting place, in

order to give a general description of the surface of the country under examination. Beginning at low-water mark of Cumberland river, under the bluff, there is observed a thick stratum of a deep blue or blackish limestone, characterized by a small number of fossils—containing regular lines of flint-nodules, some of which are round, possessing imitative shapes, and others extended in thin layers. Tracing this stratum, it is found to disappear as we descend the river, possessing, therefore, a slight inclination to the N. W. On ascending the river, however, it is seen to rise higher and higher above the low-water level, causing the natural inference, that it must, at some point to the S. E., become a surface rock, and as such it is noticed at Mill creek, and in Rutherford county.

This same gradual rising of the blue limestone is noticed in the cuts along the line of the Nashville and Chattanooga Railroad. Around the vicinity of Murfreesboro' it is found as a surface rock, but as we proceed towards Nashville it gradually sinks, till it disappears under other overlapping strata of limestone. Occurring therefore as the lowest limestone stratum in Middle Tennessee, one or two causes have operated to expose it to the surface; either the superincumbent strata have been washed away, or some gradual upheaval has given to it a higher geological altitude at one point than at another. The rounded appearance of the stratum would clearly indicate this elevating cause.

Returning to our starting point, the succeeding strata are composed of gray and blue limestone alternating, not so compact, but of a more crystalline character, containing numerous cavities filled with beautiful crystals of various mineral substances—such as carbonate of lime, sulphate of strontian, sulphate of barytes, sulphate of lime, and quartz. Beautiful cabinet specimens may be procured from newly-opened quarries. These strata embrace the rock from which is obtained the blue limestone for the foundations of our houses, and for burning into lime. It contains its characteristic fossils more numerous and somewhat different from the preceding, evidence of its belonging to a different group. Overlaying these strata is another, which, on account of the great number of shells of the *Orthis* genus, might be distinguished as the Orthis limestone, the entire rock in some places being a mass of agglutinated shells. Just above this stratum comes another which is abundantly found in some places, but appears to be somewhat isolated, though the connection of the various beds may be easily noticed on opposite sides of intervening valleys or ledges. From this stratum is obtained the large and inexhaustible quantity of ash-gray limestone, used for building purposes in the city of Nashville, of which the capitol and several public buildings are constructed. The State quarry in that vicinity opens to view a thick stratum of this limestone, one of the most interesting localities for geological observation. Overlying this stratum is

another of limestone of a compact structure, easily pulverized, breaking into flat, and somewhat conchoidal pieces, of a gray color. It is preferred for the purpose of paving and macadamizing turnpikes, on account of the readiness with which it breaks up, and the fine surface it affords when cemented together. And the last and highest in these series is a stratum possessing a yellowish color inclining to gray, well characterized also by fossils. It constitutes the uppermost stratum of the lower Silurian rocks in that region. All the rocks between this and the first stratum noticed belong to the lower Silurian system, though they may be subdivided into groups, and named according to the prevalence of each in certain localities. This entire limestone region embraces the interior counties of Middle Tennessee, possessing an area of about one-half of this district.

This stratum is about two hundred feet thick, and is of a very mixed character, sometimes being silicious and then argillaceous. "Part of it is composed of small, often very fine and uniform grains of quartz or sand, rarely containing any argillaceous or ferruginous cement, nor does it contain any intermixed mineral. Its color is mostly gray, passing into yellow or yellowish brown. The texture, sometimes granular, often passes into earthy without losing its silicious nature, resembling tripoli; and sometimes it is slaty and again passes into chert."

Surrounding it, there is a series of elevated ridges which generally take their name from the water-courses which originate in them, Caney Fork, Elk, Duck, Harpeth, and White's creek ridges. They observe no particular direction, but surround this limestone region, presenting at places bold escarpments, like the walls of a fortification. These strata are of a more recent origin, and consequently are superior to those just passed over, and belonging to the upper Silurian, Devonian, and Carboniferous systems. The first group consists of several members of limestone rocks, which crop out at the base of some of these ridges, while in others they are wanting. They possess colors ranging from gray to blue. One member being of variegated colors, with red and green spots, and plentiful crinoideal fossils, and somewhat compact in structure, would afford an excellent marble. I have examined a locality some ten miles to the west of Nashville, and incline to the belief that it would, on further exploration, be found an extensive and valuable stratum. It is susceptible of a fine polish, the encrinital stems scattered profusely through it, giving to it a beautiful appearance. Next in order in these ridges is found the black shale or slate, of various thicknesses, of an aluminous character, sometimes so highly charged with bitumen as to lead the uninformed to suspect the existence of coal. The iron pyrites, which is sometimes found in it in great abundance, renders it valuable as the source for the manufacture of alum, salts, and copperas.

To this succeeds a stratum, denominated by our late geolo-

gist, Dr. Troost, as "the Silicious stratum"—it constitutes the uplands, and embraces nearly one-half of the entire district. Constituting the table land at the base of the Cumberland mountains, it is occasionally prolonged farther westward in spurs, while at other places the mountain streams have cut deep ravines through it to the depth of the limestone beneath. Extending into North Alabama, and again entering our State and occupying all that region embraced by the counties bordering on the Tennessee river on the east—it surrounds as a zone or girdle the fertile limestone counties of the interior. This extensive stratum belongs to the carboniferous system, and is composed of several members—a silicious stratum, and a calcareous sandstone. The water-courses, originating in the interior, have cut their way through these strata, exposing the limestone and black shade below. These strata terminate before reaching the Tennessee river—the channel of this stream being upon the upper silurian limestone. About ten miles to the west of this river the entire system of Middle Tennessee is lost under the cretaceous system of the Western District.

In the examination of the various soils there is observed a constant change as we pass from one variety of rock strata to the other. They also influence the growth of the forest trees, and are of no little importance in the productions of the farm.

Minerals of Middle Tennessee.—We have already noticed the iron banks and iron manufacture of Middle Tennessee. It is one of its most important resources, while at the same time it is the most important metalliferous mineral found in this region.

In the aluminous shale of the silicious stratum may frequently be found deposits of aluminous earth, in quantity sufficient to compensate for the investment of capital. Near the Old stone fort in Coffee county, I have examined a fine locality of this mineral.

I might also notice the tripoli of White's creek ridge, and the fluate of lime of Smith county and the gypsum or sulphate of lime of Summer county—together with localities of copperas and nitre along the base of the Cumberland mountains, but none of them have as yet been supposed to possess sufficient value to render them profitable.

Palæontology of the formations belonging to East and Middle Tennessee.—To present a view of these to their full extent would require a volume of no ordinary size. The late Dr. Troost properly designated the limestone strata, belonging to the silurian formations of our State, as classic ground for the naturalist. Just previous to his death, he had prepared a memoir on the *Crinoidea* of Tennessee, which he submitted to the Regents of the Smithsonian Institution as a scientific contribution. It was accepted, but what has become of the manuscript I am unable to say. It should, by all means, be given to the scientific world, for it not only

embodies the labors of our most indefatigable geologist, but also is the only key which has as yet been prepared for interpreting the formations of our State.

There is not altogether a close correspondence between the fossils of East and of Middle Tennessee, there being many genera and species found in the one not possessed by the other.

In East Tennessee, the crinoideal fossils in the strata of variegated marble, and the trilobites and the euomphalus of the grayish limestone, are quite characteristic; while in Middle Tennessee, the conotubularia, and the orthoceratites, the calamipora and the catenipora, the terebratula and turbo of the blue limestone, the venus and belerophon of the granular white variety, and the orthis of the gray, are also characteristic, and the limestone which is found contiguous to the *silicious stratum*, and which possesses an oolitic structure, is characterized by an abundance of the pentremites and encrinites. Perfect specimens of each have been gathered in Franklin county. Dr. Troost regarded the *strombodes* as also characteristic of these strata.

With regard to the age of these oolitic limestones, there is no doubt, from the identity of the fossils peculiar to the two stratifications, that it is coëval with the silicious stratum. The aluminous slate which intervenes is devoid of fossils.

This enables us also to determine the period of the deposits of iron ore peculiar to these strata. Dr. Troost advanced the idea that they were posterior to the strata in which they are found, but anterior to the greensand of the Western district; for in Perry county the cretaceous strata overlie the deposits of iron ore.

Middle Tennessee was also the home of the Mastodon and Megalonyx. The bones are generally found in alluvial deposits. I have in my possession several teeth, a portion of the lower jaw and several ribs of a Mastodon which was dug up in Wilson county. They were found while excavating a well, eight feet beneath the surface of the ground, and lying in between the crevices of the limestone rock. In the same crevice was found a large quantity of semi-carbonized wood, and among the debris thrown out, I picked up a pine buhr. There is now no pine nearer than the Cumberland mountains, one hundred miles distant. The wood also possessed the structure of pine. The animal, it appears, became wedged in the crevice and there died. I have been informed that other fragments have, since my visit, been dug up. A large elm tree was growing upon the spot.

Cretaceous System of West Tennessee.—The Western District presents to our investigation a field entirely different from the other portions of the State. The formations peculiar to Middle Tennessee pass to the west of the Tennessee river, and disappear under the West Tennessee strata. The line where this change takes place, varies in its distance from the river, averaging, how

ever, about three miles, conforming to a certain degree of longitude. All the space between the river and the line where the cretaceous strata first make their appearance, is a bottom land, and, when of sufficient width, admits of fertile fields. Occupying the foundation of this bottom or low land, are the limestone strata of Middle Tennessee, to which succeed the system which is now to engage our attention. These strata are called cretaceous, because among its members is included chalk, while the others also partake of that nature. There is, however, no chalk in the United States.

An examination of this system in our State reveals but a few of its members, yet they are of such importance as to render the district in which they are found, highly interesting, not only for the richness of its soil, and its agricultural facilities, but for the value which will, at no distant day, be attached to one of its beds, being the storehouse from whence will be obtained the material for the renovation of the soil of the surrounding country, and thereby prolong its capability for sustaining the population to come after us.

A singular feature is observed in the physical geography of West Tennessee. Two large rivers, whose currents flow in opposite directions, bound it on the east and west. There must consequently be an intermediate ridge of high lands, to separate the tributaries which flow to the one, from those of the other. And from this high land there must be a gradual inclination to admit of a natural drainage towards these two streams. It is noticed, therefore, that after crossing the Tennessee, a succession of high hills skirt along the western bank, at an average distance of three miles from the river. Ascending these elevations, the surface of the country appears to rise gradually higher for about ten miles farther westward, from which point the slope is in an opposite direction—this is the dividing ridge. Beginning at the Mississppi line, it is found to extend into Kentucky, the pleasant towns, Purdy, Lexington, Huntingdon and Paris, being nearly on the summit of the ridge, and nearly equi-distant from the Tennessee. While, therefore, the tributaries of the Tennessee are small, owing to the short distance they have to flow, with the exception of the Big Sandy, which, though rising in the same ridge, runs a parallel north course with the Tennessee for nearly two-thirds of the width of the State, before it empties into that stream—those which rise on the western slope, after pursuing very serpentine courses, and gathering numerous streamlets into their channel, enter the Mississippi, some of the mimportant navigable streams. Of these are the Wolf, the Loosahatchie, the Hatchie, the Forked Deer, and the Obion. So numerous are the small streams which become tributary to them, that the whole district presents the appearance of net-work—an arrangement highly conducive to its agricultural facilities. In pursuing a

line of observations from the Tennessee river to Randolph, on the Mississippi, we note the following peculiarities. At the distance of about five miles from the Tennessee, there is observed a series of hills—not contiguous ridges, skirting along the stream, each hill appearing isolated with rounded summits. Where washings have taken place, successive strata of blue marly limestone, white and red clay, and argillaceous sandstone, are exposed to view, cropping out from the western declivities, or between these rounded hills. The highest of these points is familiarly known as Pilot Knob, and is supposed to be at least 400 feet above the level of the river. These strata are seen to dip towards the north-west at an angle of 20° lying upon the strata of the Tennessee river, and forming, by their inclination, a basin for the entire strata of West Tennessee. I will presently allude to an important fact relative to this underlying limestone stratum.

These limestone strata remain as the surface rock, except where covered by soil, until we reach Camden, where they disappear under a white silicious soil. To this point there is a gradual ascent, but to the west of it the surface of the country gradually slopes to the bluff at Big Sandy. This bank or bluff is neither so high nor so abrupt as that at the Tennessee river, and is composed of the same white sandy soil. Passing over the low land skirting this river, we observe, as we begin to ascend to the table land, a reddish clay soil, which readily crumbles, while above it we again come upon the white soil. Here, as on Big Sandy, it constitutes the surface soil of the elevations. Descending thence to Huntingdon, we notice the red soil which again disappears under the same white soil, on the elevated point near McLemoresville. Thus alternating, the high and table lands present the same appearance to the Mississippi, except when covered over by the rich black alluvium of the river low lands. The successive strata passed through in sinking wells have exhibited the same white clay, red clay, blue marly limestone and white sand. These wells have been sunk to the depth of 100 feet. I do not know whether any attempts have been made to procure *Artesian wells*, but from the general structure of the country, the inclination of the strata, lying also upon the slightly-inclined strata of Middle Tennessee, would seem to favor the idea that if borings were made to the depth of 400, 500, or 600 feet, a stratum would be reached from whence water would flow forth. The success of such an experiment would be of incalcuable benefit to the country.

In the south-eastern counties, we find more fully exposed to view the marly limestone and the green-sand strata. These strata form almost entirely the surface of McNairy, extending also into a portion of the adjoining counties, but soon disappear under the surface soil. Here is presented another feature in the physical geography of this district. Extending from the Mississippi to

the Tennessee river, through the northern counties of the State of Mississippi, is an elevated ridge which divides the waters of that State from those of our district. Towards this ridge the strata of McNairy and Hardin counties point, thus giving to them a dip to the north-west—at the same angle of 20 degrees. It is easy to imagine therefore a basin existing in the north-west counties. And that is in the vicinity of New Madrid, the seat of volcanic action in 1812.

The seventh report of our geologist contains an account of the green-sand of McNairy county, which is said to be "in the form of small dark grains of the size of gunpowder, of an olive or blackish green color, not gritty, but easily crumbled between the fingers." Sometimes these grains merely adhere together in lumps, but then again are cemented by the calcareous matter of the marl. The analysis of the green sand shows it to be a true silicate of potash, the principal ingredients being silica, potash, carbonate of lime, alumina, and protoxide of iron. The marl also contains an important proportion of carbonate of lime, the two deposits in this respect differing from the New Jersey marl. In these marls and green sands, *as well as in her productive soils*, consists the wealth of West Tennessee. The immediate spots where they form the surface rock, may be unproductive, but it is the unproductiveness of excessive fatness or richness. Marls or green sands only display their wonder-working properties when placed within the influence of organic matter. They are mineral manures, and to promote the growth of vegetation there must be in the soil a proportion of decomposing vegetable matter with which it readily forms soluble compounds. Their beneficial effects are observable, as well in renovating worn-out lands, as in tempering the quality of black alluvial soils. To the first, they will restore the proportion of lime and potash which an exhausting system of tillage had removed in the form of crops—to the second, they will serve to open the mass of vegetable matter, and, by forming new compounds, warm up the cold alluvium, and render it fit for cultivation. The system of agriculture generally pursued in new countries, is conducted, by reason of the natural productiveness of the soil, with so little reference to scientific principles, that it is only in those countries where a constant tillage has exhausted the soil of all its powers to produce, that the application of science shows what rich treasures nature has provided for the wants of man. Nothing is truer than that a succession or rotation of crops is necessary to preserve the energies of the soil; and that if the same production is raised for several years upon the same field, it gradually degenerates, at last yielding no fruit to reward the husbandman for his toil. The plant takes up from the soil only those ingredients adapted to its well-being—but, like the impoverished animal, where these are wanting, it will feed upon those things which may be detrimental to

its growth, and cause it to sicken and die. The analysis of soils shows what they are capable of producing, and enables the farmer to apply the appropriate fertilizer for rendering them productive in the highest degree.

ART. VII.—THE PRACTICAL MINER'S GUIDE. By J. BUDGE. No. 3.

(Continued from page 361.)

PLANE TRIGONOMETRY BY THE TABLES.

CASE I.—WHEN THE HYPOTHENUSE IS GIVEN.

Rule.—Look in the first table, and against the given angle stands the base and perpendicular, answering to one fathom of the hypothenuse; take out these numbers and multiply them respectively by the length of the hypothenuse.

EXAMPLE.

Given the angle 23° 30′, and hypothenuse 12 fathoms; the base and perpendicular are required.

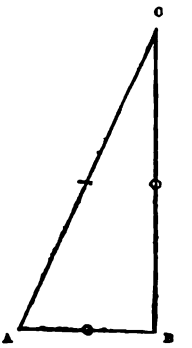
OPERATION.

Base.	Perpendicular.
Feet 2 . 4·70933	Feet 5 . 6·02833
12	12
28 . 8.51916	66 0·33996.

SCALE.—40 feet to an inch.

BY CONSTRUCTION.

Process.—Draw the line A B of any length, make the angle C=23° 30′ by a scale of chords, or with a protractor; draw the hypothenuse A C=72 feet from a scale of equal parts. From C let fall the perpendicular C B; then A B C is the triangle required. A B, measured by the same scale of equal parts, will be 28 feet 8½ inches, and B C will be 66 feet.



CASE II.—WHEN THE PERPENDICULAR IS GIVEN.

Rule.—Look in the second table, and opposite the given angle will be found the base and hypothenuse corresponding to one

fathom of the perpendicular; multiply these numbers separately by the length of the perpendicular.

EXAMPLE.

Given the angle 39° 30′, and perpendicular 9 fathoms 3 feet; the hypothenuse and base are required.

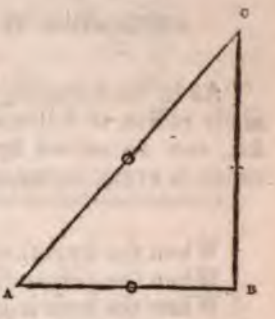
OPERATION.

		fath.	ft.	in.
3	½	0	4	11·3522
				9
		7	2	6·1698
		0	2	5·6761
Base		7	4	11·8459*

		fath.	ft.	in.
2	½	1	1	9·3096
				9
		11	3	11·7864
		0	3	10·6548
Hyp.		12	1	10·4412

BY CONSTRUCTION.

Process.—Draw the line A B of a sufficient length, at any point B erect the perpendicular B C, which make equal to 57 feet by a scale of equal parts. At C make the angle—39° 30′ the complement of A. From C draw the hypothenuse, and it will cut the base A B in the point A; then will A B measure 47 feet, and A C 73 feet 10 inches.



CASE III.—WHEN THE BASE IS GIVEN.

Rule.—Look in the third table, and opposite the given angle (as in the former cases) the corresponding numbers to one fathom of base will be seen, which being multiplied by the given length of the base, produces the hypothenuse and perpendicular.

EXAMPLE.

Given the angle 20 degrees and base 28 feet 9 inches; the hypothenuse and perpendicular are required.

		ft.	in.
∠20°	½	17	6·51392†
			4
		70	2·05568
	¼	8	9·25696
	⅛	2	11·08565
		2	2·31424
Hyp.		84	0·71253

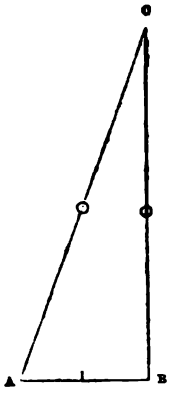
		ft.	in.
	½	16	5·81837†
			4
		65	11·27348
	¼	8	2·90918
	⅛	2	8·96972
		2	0·72729
Perp.		78	11·87967

* It has been before observed that it would be better to bring the answer out in feet than in fathoms, as in the last case.

† These numbers stand in the tables in fathoms, &c., the hypothenuse will be found 2 fathoms, 5 feet, 6 inches, &c., and the perpendicluar 2 fathoms, 4 feet, 5 inches, &c.

BY CONSTRUCTION.

Process.—Draw the base A B which make=28 feet 9 inches, from a scale of equal parts, at B erect the perpendicular B C, make the angle A = 70° and draw the hypothenuse A C to cut the perpendicular B C in the point C, then will A C measure 84 feet, and B C 78 feet 11½ inches.



APPLICATION OF THE TABLES TO DIAGONAL SHAFTS.

REMARKS.

As in the foregoing cases each side of the triangle is distinctly made radius, it follows that every problem in oblique dialling, &c., can be solved by one or the other of these cases; because in every instance, a side and the angles are always given.

GENERAL RULE.

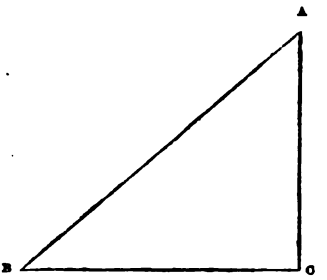
When the hypothenuse is given, work by case the first.
When the perpendicular is given, work by case the second.
When the base is given, work by case the third.

EXAMPLE I.

A diagonal shaft A B was found to measure 84 feet,* and the angle of declination observed to be 48 degrees; required the base B C, and perpendicular A C.

BY CASE I.

	ft.	in.
∠48°	4	5·50643
		7
	31	2·54501
		2
Base	63	5·09002
	ft.	in.
	4	0·17740
		7
	28	1 24180
		2
Perp.	56	2·48360



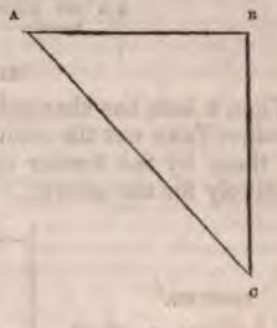
* When the given line is denominated in feet, it must be brought into fathoms by dividing it by 6, (the number of feet in a fathom;) thus, in the above example the shaft being 84 feet is 14 fathoms, and therefore the numbers are multiplied by 7 and 2, which are equal to 14.

EXAMPLE II.

A perpendicular shaft B C, measuring 57 feet, was found to intersect an underlaying shaft A C, whose angle of acclivity was observed to be 50° 30′; required the length of the underlaying shaft A C, and the distance from the perpendicular at the surface A B.

BY CASE II.

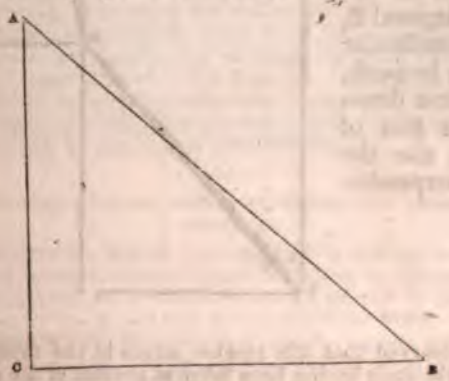
			ft.	in.
∠50° 30′ Comp. 39° 30′	Base	÷	4	11·8522
				9
			44	6·1698
			2	5·6761
A B			46	11·8459
	Hyp.	÷	7	9·3096
				9
			69	11·7864
			3	10·6548
A C			73	10·4412



NOTE.—In the above example the angle having again been taken with the horizon, the operative angle will be 39° 30′, because 90°—50° 30′—39° 30′. We may also observe that the length of the shaft being 57 feet, the multiplier is 9½, or 9 fathoms, 3 feet.

EXAMPLE III.

A horizontal cross-cut B C from the foot of a diagonal B A to a perpendicular shaft C A was found to measure 224 feet 8 inches, and the angle of acclivity (taken at B, the foot of the shaft) 40 degrees; I require the respective lengths of the hypothenuse A B and perpendicular A C.



BY CASE III.

		ft.	in.			ft.	in.
∠40° Comp. 50°	÷	7	9·98932*	÷	5	0·41517	
			12				12
		93	11·87184		60	4·98204	
			3				3
		281	11·61552		181	2·94612	
		7	9·98932		5	0·41517	
	÷	2	7·32977	÷	1	8·13839	
		0	10·44325		0	6·71279	
A B		293	3·37786	A C	188	6·21247	

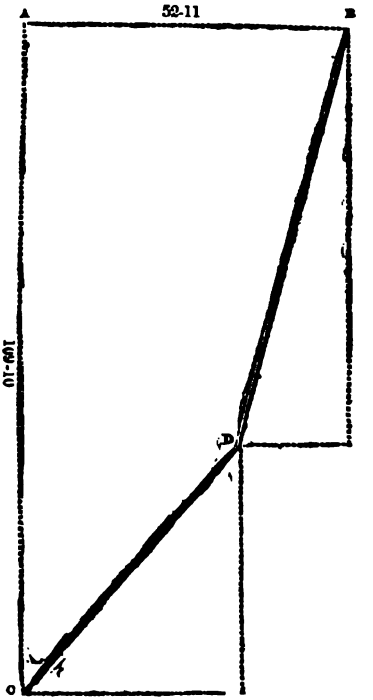
[EXAMPLE IV.]

When a lode has changed its underlay.

Rule.—Take out the numbers opposite the given angles, and work them by the former cases, then add their sums together respectively for the answer.

PROBLEM.

In dialling a shaft sunk on a lode, it was found that the first draft B D measured 71 feet, on an angle of 14° 45′, but from that depth to the foot of the shaft C the angle proved to be 40° 15′, and the length D C 54 feet; required the distance from the brace of the diagonal B, where a perpendicular shaft ought to be sunk, in order to come down exactly at the foot of the underlay; also the depth of the perpendicular A C.



* It will be observed that this number stands in the table 1 fath. 1 ft. 9·98932 in., and the angle having been taken at the foot of the shaft, the complement of that angle (*i. e.* what it wants of 90°) must be used, therefore the above tabular numbers will be found in the column opposite 50°, being the complement of 40°.

(To be continued.)

JOURNAL OF MINING LAWS AND REGULATIONS.

MINING LEGISLATION.

A correspondent of the Sacramento *Union* writing from St. Louis, Sierra county, suggests that the Legislature of California should impose a tax upon money paid in the purchase of mining claims—that such money should be regarded in the same light as ditch stock, or money loaned and secured by mortgages on mining claims. The principal object to be obtained from such a law to the benefit of the miner is that it would thus legalize such transfers. The writer in the *Union* says:

"As the miner's laws in this district read, a man is allowed to purchase two mining claims, but if he should buy a third claim, and pay $5000 for it, any man who felt so disposed, can jump said claim and hold it. Now, Mr. Editor, should such a law as that be recognized in any court in a civilized country? According to the ruling of our District Judge, Niles Searles, these laws must be recognized to a certain extent. I am one of the hard-fisted, and have a good opportunity of knowing the sentiments of nine-tenths of the miners about here, and they say let the Legislature pass a law to tax money paid for claims, if by doing so they will secure to the miner a title that will hold good against the encroachments of unprincipled men. What we want is something permanent and legal, so that we can safely invest our money here instead of sending it to the older States."

The following remarks of the *Union* in reference to another portion of its correspondent's letter, contain some facts with regard to the law of attachment as applicable to mining claims, which may be new to most of our readers. It is certainly a matter of interest to all that we should have a decision in reference to the matter of selling mining claims under execution from the highest judicial tribunal in the State:

"'A miner,' in a communication given in this paper, suggests that there is an inconsistency in allowing mining claims to be sold under attachment, when they are admitted not to be taxable property. We think Judge Howell, of El Dorado, decided, in a case brought before him over a year since, that a mining claim could not be sold under execution—that the mines were upon public land—that a mining claim was real estate, and that a miner could not acquire a title in said real property which could be levied upon and sold under execution. This is our recollection of Judge Howell's ruling. Since that time cases have been carried to the Supreme Court, with the expectation that the point would be adjudicated by that Court, but they were all decided upon other grounds, and hence the question of property in mining claims has never been answered by our highest judicial tribunal."

INTERESTING DECISION.—THE RIGHTS OF MINERS AND LABORERS AT OUR COLLIERIES.

The firm of Struthers & Reed were engaged in mining Coal at Tuscarora. Judgments were obtained against John S. Struthers for his separate debts, on which executions were issued—under which his interest in the firm of Struthers & Reed was levied on and sold by the sheriff for $1900. Some personal property belonging to John Struthers individually was also levied on, and sold for $252. The proceeds of the sales under the executions were paid into Court. The firm of Struthers & Reed were indebted to their miners and laborers, who gave notice of their claims to the sheriff before the sale of the property. The Court appointed an auditor to distribute the fund, who awarded it to the miners and laborers in preference to the execution creditors. The Court of

this county confirmed the Report of the auditor, and E. M. Beatty & Charles Heasler, the execution creditors, appealed from this Judgment to the Supreme Court.

Appeal of Elizabeth M. Beatty & Charles Haesler from the decree of Common Pleas of Schuylkill County.

The opinion of the Court was delivered by WOODWARD J.

We give full effect to the third section of the Act of Assembly of 2 April, 1849, for the protection of Miners, Mechanics and Laborers, when we treat their claims as a preferred lien against the debtor's goods to be satisfied out of the proceeds of a sale upon execution, like a landlord's rent before the execution creditor can take any thing. Their lien is against their debtor's property. Now who were the debtors of these Miners? Struthers & Reed confessedly. Was there a sale of the property of Struthers & Reed on the execution in question? It cannot be pretended, for an execution against one of several partners does not sell any part of the partnership effects, but only the contingent interest of the partner in the final balance after all partnership debts are paid, *Doner* vs. *Stauffer*, 1 Penna. R. 198, *Deal* vs. *Bogue*, 8 H. 233. It was not in this case even in point of form a sale of any thing more, for the levy was upon the right, title and interest of John S. Struthers in the partnership effects.

The liens of the partnership creditors were unaffected by such a levy and sale, and where a creditor's lien is not divested by a judicial sale he has no claim on the proceeds. The Miners had all the rights they ever had, and that the Act of Assembly intended to give after the sale as fully as before. It would endanger the interests of laborers to hold them entitled to the proceeds of the sale of a partner's interest, where a partnership was their debtor, because this would make every such sale divest their lien against the property of the partnership, which is the essential element of their security.

A difficulty is suggested in argument not applicable to this case, but which might arise where the interest of both partners should be sold at the same time for their separate debts. What would become of the rights of laborers in such a case? It is not necessary now to answer this question; but I have no doubt the courts would have power, under the Act of Assembly which gives them "the supervision and control of partnerships," to protect the rights of partnership creditors in such a case.

However this may be, these miners had the remedy in their own hands; for the partnership property, which was their security, survived the sale, and they should have looked to that rather than to the price which the contingent interest of one partner therein brought at the sale.

And now, April 4th, 1857, this cause having been fully heard and considered it is ordered and adjudged that the decree of the Court of Common Pleas of Schuylkill County be reversed and set aside, and hat the fund in Court be distributed first to the satisfaction of the execution of Elizabeth M. Beatty, and the residue thereof to the execution of Charles Haesler, and that the appellees pay the costs of this appeal.

COALS AND COLLIERIES.

SCHUYLKILL COAL TRADE.

The quantity of coal sent by railroad and canal from Jan. 1 to April 23, 1857, is:—

	Tons.
By railroad	547,277 02
" Canal	87,624 01
Total by canal & R. R.	634,901 03

Shipments to same period last year:

By railroad	568,697 19
" Canal	80,790 08
	649,488 07
	634,901 03
Decrease in 1857, so far,	14,587 04

SCRANTON COAL TRADE.

The total shipments for 1857, to April 23, are:

North,	50,389 04
South,	74,625 02
	125,014 06

LEHIGH COAL TRADE.

Total amount of shipments for 1857 to April 18:

By Canal,	Tons.
Lehigh Coal and Nav. Co.,	6,316 05
Spring Mountain Mines	2,601 15
East Sugar Loaf do	75 00
Coleraine do	1,258 01
Stafford do	222 13
N. York and Lehigh Coal Co.,	1,532 08
German Penna Coal Co.,	125 17
South Spring Mountain Coal	151 07
Cranberry Mines	73 10
Council Ridge	408 16
Buck Mountain Coal Co.,	3,725 11
Wilkesbarre Coal Co.,	77 16
Hartford Coal Co.,	60 02
Total	16,629 01

LEHIGH VALLEY R. R.

Spring Mountain Mines,	30,929 17
East Sugar Loaf do	20,343 07
N. York & Lehigh do	15,660 19
Council Ridge do	19,009 00
German Penna. do	1,106 14
Coleraine & Stafford do	17,917 04
Dolbin & Dehaven do	269 02
Hazleton do	4,060 05
Total	109,290 08

Shipments to same period, last year:

By Railroad,	20,568 08
By Canal	24,076 14
	44,645 02
	125,919 09
Increase in 1857, so far	81,274 07

LYKENS VALLEY COAL TRADE FOR 1857.

	Tons.
Lykens' Valley Coal Co.,	12,206
Short Mountain Co.,	7,357
Total,	19,763

TREVORTON COAL TRADE FOR 1857.

Total,	6,887 05

BROAD TOP COAL TRADE FOR 1857.

Total,	13,993

CUMBERLAND COAL TRADE FOR 1857.

Total,	144,500

PINEGROVE COAL TRADE FOR 1857.

Union Canal	23,542 12
Swatara Railroad	18,983 17

SCHUYLKILL COUNTY RAILROADS—1857.

The following is the quantity of Coal transported over the different Railroads in Schuylkill County, to April 28.

	Week.	*Total.*
Mine Hill and S. Haven R. R.	26,537 08	211,663 07
Mt. Carbon "	3,284 17	32,857 12
Schuylkill Valley "	9,057 00	63,553 13
Mt. Carbon & Pt. Carbon "	14,589 11	138,777 08
Mill Creek "	11,705 03	116,268 18
Little Schuylkill "	6,466 11	73,423 16

New York Coal Trade, April 23d, 1857.—There is no change to note in the value of anthracite. The arrivals have been liberal and the demand unusually active for the time of year—the season proving unusually cold and backward. We continue to quote by the cargo for Chesnut at $4 to $4 25—for Lump and prepared $4 75 to 4 85—the latter price for large size Lehigh. The retail price continues at $4 50 to 5 50. The supply of foreign is in excess of the demand, and prices are lower and unsettled; last sale of Orrel at 5 75 for "Barley Brook." Cannel is nominal at 9 25 to 9 50 per ton.

Port Richmond Coal Trade, April 24, 1857.—We have no change to note since last week. The demand is increasing gradually.

BOSTON COAL TRADE, April 23, 1857.

Sales of Sydney at $7 50, and Pictou at $8 per chaldron, cash. In English Cannel we notice sales of 25 chaldrons at $12, and 20 chaldrons at $12 50 per chaldron. Anthracite in retail demand at $7 per ton.

Wholesale prices per ton of 2000 pounds.

Schuylkill, white ash,	$5	75	to	$6	00
do red ash,	6	00	to	—	—
do lump,	6	75	to	7	00
Lehigh, lump,	7	00	to	7	25
Lackawanna,	5	75	to	6	00

Retail prices per ton of 2,000 pounds.

Cannel,	$15	00	to	—	—
Newcastle coarse,	11	00	to	—	—
do fine,	—	—	to	—	—
Orrel,	—	—	to	—	—
Scotch,	11	00	to	—	—
Welsh,	—	—	to	—	—
Cumberland, run of pit,	7	50	to	—	—
do fine,	—	—	to	—	—
do coarse lump,	—	—	to	—	—
Sydney, coarse,	10	00	to	—	—
Pictou, coarse,	—	—	to	—	—
do fine,	—	—	to	—	—

Lackawanna, lump,	$7 00	to	—	—
Lehigh and Schuylkill lump,	7 25	to	7	50
John's Lump, (Schuylkill)	7 50	to	—	—
Prepared white and red ash,	7 00	to	—	—

Prices of Coal.—The Delaware, Lackawanna & Great Western Railroad Co. have fixed the following prices for their Coal until June 1, at the points named below:

Delivered on board of Boats at Ithaca.

Lump,	$3 75
Steamboat,	4 00
Large Egg,	4 05
Small Egg, Stove and Foundry Lump,	4 45
Chestnut,	3 45

Delivered on board of Boats at Binghamton.

Lump,	$3 30
Steamboat,	3 55
Large Egg,	3 60
Small Egg, Stove and Foundry Lump.	4 00
Chestnut,	3 00

Delivered in Cars (at Railroad Depot) at Syracuse.

Lump,	$4 25
Steamboat,	4 50
Large Egg,	4 55
Small Egg, Stove and Foundry Lump,	4 95
Chestnut,	3 95

COAL LANDS OF THE WESTERN VIRGINIA AND KENTUCKY RAILROAD AND COAL CO.

The Company possess 34,000 acres of coal land, and on which iron has also been found in great abundance in Johnson and Lawrence counties, Kentucky, on and near the Big Sandy. They have also 2,800 acres in the Kanawha region in Virginia, on the Elk river.

The following statements from impartial and disinterested sources will show the great value of their great mineral property.

Kentucky coal lands.—Dr. Owen, State geologist of Kentucky, in a recent work, after stating that the coal field stretches across the State, and divides it into upper and lower districts, remarks:

"The upper coal measures of the eastern coal field, in the counties of *Lawrence* and *Johnson*, Floyd, Harlan and Knox, embrace very thick beds of coal, containing from 60 to 63 per cent. of fixed carbon, with a very small ash, lying from 50 to 250 feet above the superficial drainage. In Lawrence and Johnson counties (where this Company's property is situated), these crop out in the hills bordering on Big Sandy, and are, therefore, easily accessible and convenient for transportation to market."

He concludes by saying:

"No region, either in this country or Europe, affords greater facilities for the production of cheap iron, than this iron and coal district."

Professor Mather, of Ohio, in his geological survey of the eastern part of Kentucky, makes the following statements as to the iron and coal of this region:

"Many distinct beds of coal were seen, examined, and traced out over many miles along and on both sides of the railroad line. The coal beds that were seen and are deemed worthy of extensive working, are on the waters of the Little and East Forks of the Little Sandy, and on the waters of Big Sandy.

"At the Buena Vista Furnace, and at Cannonsburg, there is a solid, unbroken stratum of coal, six feet in thickness, or about 10,000 tons per acre.

"The country for miles is equally well provided with coal, and may be considered inexhaustible, and will furnish all needed supplies of this useful fuel for ages of time.

"Iron ores abound on the route of the railroad from the head of Triplet's

Creek to the mouth of the Big Sandy, but are most abundant between the Little and Big Sandy. The beds are numerous, and several are workable on every hill. The ore is several feet in thickness on many of the hills, and if we allow that but one-tenth of the two and a half feet of ore will be obtained by stripping, we would at the lowest estimate have 506 tons of iron per acre."

Secretary of the Breckenridge Coal Co. on Iron and Coal, in the region of the Big Sandy, where the property of this Company is located.

This gentleman not long since visited the coal and iron region in Eastern Kentucky, and he thus answers several questions put to him by a friend as to quality and quantity of the coal and iron found there.

Question.—What reputation has this coal compared with other coals in market?

Answer.—It is esteemed equal to the *best*, and will always command a much higher price than the Pomeroy coal, although I have taken that as my stand ard in fixing the price. A gentleman well acquainted with both these coals, told me that it would always bring one dollar per ton more than the Pom eroy, and yet that coal has made its owners large fortunes. Pomeroy is sixty-seven miles above the mouth of Sandy in Ohio.

Question.—Did you, when on Big Sandy river, see any indication of iron ore?

Answer.—I found the same iron ore on Sandy which is so celebrated in Ohio, and which has been so successfully worked. I design to make the iron ore of Sandy the subject of a special report as soon as I shall have again visited that section of the country. I have no hesitancy in saying that the day is not far distant when this coal and iron will entitle Sandy river to be called the Staffordshire and Birmingham of America. Believing I have written the truth, and only the truth, I am content to await the development which enterprise and capital, now directed to Sandy river, must soon make.

Yours, with respect,
SAM'L F. HEADLEY.

This impartial testimony, and from those engaged in similar and rival enterprises, must convince the most incredulous as to the great value of this Company's coal lands, particularly as the 34,000 acres possessed by them were selected from the best mineral lands in that vicinity.

This Company also possess 2.800 acres of land on the Elk river in the Kanawha coal region, Virginia. This property lies in the vicinity of the celebrated Winnefred and Peytona mines.

The value of mining property in this region is thus certified to by that eminent geologist, Wm. Gibbs McNiel, Esq.:

"That it cannot be denied that the mineral wealth of the Kanawha and Guyandotte valleys alone far surpasses that at this time developed throughout the whole range eastward of the Alleghany mountains."

If this Company estimated their property at the rate coal and iron lands are now selling in Maryland and Pennsylvania, say from $300 to $500 an acre, it would bring the enormous sum of twelve million dollars.—*Company's Report.*

NEW YORK AND THE COAL FIELDS OF PENNSYLVANIA.

An Albany letter to the *Courier and Enquirer*, dated March 24th, says:

Mr. Bradford urged upon the Senate the necessity of a survey of a route for the extension of the Chenango Canal, so that the coal of Pennsylvania might be made available for transit by that work, and its revenues (which greatly need it,) be enlarged. This concerns the Scranton Company. The Chenango Canal is a work concerning the building of which there would be now but small question. It was ordered in days when the simple strength of

the iron bar was but little known,' and when Clinton had graven the word Canal so deeply on the State policy, that no other improvement could efface it.

New York is reaching after the coal beds of Pennsylvania with a zeal that will bind that State so indissolubly to our own, that there will be certainty of her prosperity in business and hope of her improvement in politics. Our people are sending water way and iron way to the mines, and those northern counties which but a very few years since were as desolate as the hermit could desire, are taking rank among the most valuable of all the State. Success to them; the busy miner in the hill is working to light more brilliantly the poor man's hearth—the busy lumberer in Venango is furnishing the material for the poor man's home.

SMOKE CONSUMPTION.

Messrs. Case and Soule, of Amsterdam, N. Y., state that they effect this object completely by adopting an arrangement as follows: "We divide the flues of the boiler into two sets, upper and lower. The flame and gas leave the furnace through the lower set, and retur in the upper set. In the smoke box, at the front end of the boiler, we encase a fan-blower in a drum, with open journals, the mouth of which drum covers all the upper flues. When the smoke enters the smoke-box, it is drawn into the drum and driven back to the fire. The combustible gases are lighter than the carbonic acid gas, which, if blown back to the fire, would quench it instantly. The dismissal of this gas is the secret of smoke-burning. We dispose of it by means of a characteristic of the gas itself, viz., its great specific gravity. Our blower being well up in the smoke-box, and the open journals being protected by diaphragms, which shoot all the hot air to the bottom of the box before it can reach the journals of the blower, none but the combustible gases can rise to the blower, while the heavy carbonic acid gas stays at the bottom and runs out continually at an appropriate orifice. On the same journals we have two other fans outside the smoke-box which feed the fire with oxygen, one under the grate, and the other above the fuel in the flames. Thus our fire has no escape except of carbonic acid gas."

STONE COAL IRON.

A communication in the Cleveland *Herald* says it is more than ten years since the process of making pig iron from raw mineral coal was successfully in use in Northern Ohio; and that while there are a great number of anthracite and coke furnaces in Pennsylvania, there are none for burning bituminous coal in its raw condition, in that State.

In the counties of Summit, Stark, Trumbull, and Mahoning, in Ohio, the following stone coal furnaces have been built within ten years, most of which are now in operation, running out from 12 to 22 tons of metal in a day:

Reese, Vinton & Co., Tallmadge.
Wilkinson & Co., Lowell.
Ford & Howard, Youngstown.
Philpot & Co., Youngstown.
Crawford & Co., Youngstown.
James Wood & Co., Brier Hill.
Volcano Works, Masillon.
Masillon Iron Co., Masillon.

This communication continues: "The difficulties these enterprising companies labored under arose from the inferior quality of the metal. But since the magnetic ores of Lake Superior, New York and Canada have reached this region, these furnaces can make a pig almost equal to Hanging Rock charcoal iron. Mr. Charles Howard is now running out from 16 to 18 tons per day, and at the Volcano and Masillon Company's Works from 19 to 21 tons."—*Ironton Register.*

The following paragraph we extract from a recent number of the Masillon *News:*

"During the past week our iron furnaces have been visited by an experienced iron master of Pennsylvania, who has a capital of over a million

lars now under his control in that business, and who was the first manufacturer of iron from raw coal in this country, and he gave it as his opinion that the furnaces here produced more and better iron than any other works in the country. From such a source the remark is highly gratifying, and we hope the fact may lead to the investigation of the subject more closely by persons seeking to engage in the business, and the adoption of this point for a location. The two furnaces now in operation here supply about 280 tons a week of the best of iron. In a few days the third stack will be ready for work, and then 140 tons more will be produced. The quantity of ore and coal is sufficient to supply any number of such furnaces and the demand for iron is unlimited. The profits upon the investment are good; but they can be largely increased."

IRON AND ZINC.

EXPERIMENTS FOR TESTING IRON.

The British Government has made some valuable experiments, in order to ascertain whether guns manufactured from charcoal iron exhibit great superiority over those made according to the same system, of iron reduced from its ores by mineral fuel. For this purpose, specimens of charcoal pig iron were collected from different countries for comparative examination and test purposes. Of two specimens of white iron from Silesia, obtained from different ores, both were hard and brittle; these irons were proposed for admixture with dark gray irons, but were considered not fit for the purpose. Some French iron, reduced by charcoal from hæmatite ores, was dark, soft, fine-grained, and uniform in texture, and its general characteristics were similar to Swedish gray iron, but superior in reference to the amount of silicium contained. Specimens of Nova Scotian and American irons were pronounced of excellent quality. The Swedish gun metal bore great resemblance to the Russian. The French gun metal was from the cannon foundry at Rouelle; the Belgian from the government foundry. The result of the analysis rendered it certain, that iron smelted with mineral fuel may be obtained in abundance in Great Britain, containing not more phosphorus or sulphur than is usually found in charcoal iron; and that proofs exist of the ease with which silicium may be removed from pig iron. The conclusion which the corps of experimenters arrive at is, that England is not dependent on a supply of charcoal iron for the production of durable guns. The analysis of Russia iron, of 7.135 specific gravity, showed iron 94.36; combined carbon, .47, graphite, 2.83; silicium, 1.10; sulphur, .02; phosphorus, .37; maganese, .85.

IRON OPERATIONS AT LAKE SUPERIOR.

The iron mines at present worked are situated from three to sixteen miles from Marquette, a pleasant and thriving village of 1,000 inhabitants, overlooking Lake Superior, located near the mouth of Carp river, 140 miles above Saut Ste Marie.

The mine nearest to the lake is the Eureka, about two and a-half miles from Marquette. The ore here is not so easily or cheaply obtained as at the Sharon or Cleveland mountains, but it is of surpassing richness, and yields an iron of the finest and best quality for cutlery, &c. It has not been worked so extensively as the others, but is being prosecuted with vigor.

The Jackson Iron Mountain, owned by the Sharon Company, is situated 14 miles from Marquette; and the Cleveland Mountain, owned by Wm. J. Gordon

and others, of Cleveland, is two miles beyond. A plank road, laid with flat iron rails, is in operation from Marquette to both of these mines, and the ore is transported in cars, drawn by horses and mules. One span of horses or mules will draw a car, containing five tons of ore, and make one trip a day. The operative forces at each of them the present season are about equal, and they send to Marquette an aggregate of from 800 to 1,000 tons per week. These mountains rise gradually to a height of six or seven hundred feet, and are a solid mass of iron ore, yielding from fifty to sixty per cent. of the best iron in the world.

Two and a-half miles beyond the Cleveland, is the New England Iron Mountain, which is said to abound with ore of equal richness and quality with the others, but as the railroad is not yet completed to it, nothing has been done to develope it. A mile or two further on we reach the Burt Iron Mountain; but as they all bear so strong a resemblance to each other in the quantity, quality, and richness of ores, a description of one answers for them all. That the iron of this region is inexhaustible, admits of no doubt, and that it is the richest and best in the world has been clearly proved by analysis and practical demonstration.

Heman B. Ely, Esq., and others, are constructing a substantial railroad from Marquette to the Burt Mountain, and a company have been formed to continue it on to the Wisconsin State line. Six or eight miles of this road are completed, laid with heavy T rail, and a locomotive is running upon it. The grading is nearly completed to the Jackson Mountain, 14 miles, and the iron will be laid this fall, or early in the spring. The completion of this road will have a tendency to reduce materially the price of ore at Marquette. It is now held at $5 per ton, delivered on the wharf; it can then be sold at $3 50, and yield as fair a profit as it now does at $5.

The Sharon Iron Company have expended some $300,000 in the construction of a substantial breakwater and wharf, twelve hundred feet long, at Marquette. The harbor is well protected, except against an east wind, which blows directly in; but an expenditure of fifty thousand dollars, in extending the breakwater already constructed, would make it safe at all times.

In 1848, two years after the discovery of iron, the first Bloom Forge on Lake Superior was built by the Jackson Iron Company. It is situated about ten miles from Marquette, in the vicinity of the Jackson Mountain. It is a small affair, having only two fires, and as the machinery proved imperfect, but little has been done with it.

The second forge was built by the Marquette Iron Company in 1850, located at the village of Marquette. This had four fires, and was worked by steam. It was in successful operation about eighteen months, when it was destroyed by fire in 1852.

The third Bloomery was built in 1853, by Mr. McConnell. It is situated on the Dead River, six miles from Marquette, has two fires, and is worked by water-power.

The fourth and most extensive and successful Bloom Forge, on Lake Superior, is that of the Collins Iron Company, situated on Dead River, three miles from Marquette. This was completed in 1855. It was worked by water-power, has eight fires, and is capable of manufacturing 2,000 tons of blooms per annum. C. A. Trowbridge, Esq., of Detroit, is the Managing Director of this Company, and the Bloomery is under the immediate charge of Robert J. Graveræt, Esq., of Marquette.

The Detroit and Lake Superior Iron Manufacturing Company, with a capital of $100,000, has commenced the erection of a substantial Charcoal Blast Furnace, in Hamtranck, a mile or two above the city of Detroit, which will be completed about the first of October. Its capacity will be about 2,500 tons of pig per annum.

But the most extensive Iron Works in Michigan are located at Wyandotte, a young and flourishing village on the Detroit River, ten miles below the city

of Detroit. The Eureka Company has here, in full operation, a Charcoal Blast Furnace, capable of making 3,000 tons of pig iron per annum. It is supplied with ore from Lake Superior, which, being entirely free from sulphur and phosphorus, produces a quality of pig which has no superior in purity and strength.

The Wyandotte Rolling Mill Company have in operation a mill for rolling Merchants' Bar Iron, which is capable of producing 3,000 tons of finished iron, of the very best quality, per annum. It cost $75,000, and gives constant employment to over one hundred men.

The same Company have nearly completed, and which will go into immediate operation, a mill for re-rolling and manufacturing railroad bars. The mill, which is 140 by 200 feet in size, cost $80,000. It will be worked by two low pressure engines of 100 horse power each, giving employment to three hundred men, and produce 12,000 tons of railroad bars per annum. The works are owned by E. B. Ward U. Tracy Howe, S. M. Holmes, and others, of Detroit. George R. Givan, Esq., of Detroit, is the general agent for all these works.

JOURNAL OF GOLD MINING OPERATIONS.

CALIFORNIA GOLD MINES.

A writer, who appears to be familiar with the subject, discusses as follows in the San Francisco *Herald* the alleged falling off in the yield of the California Gold Mines:

An article recently appeared in your paper referring to the falling off in yield of the gold mines of California, which may create an erroneous impression as to the facts of the case, and of the causes which may tend to diminish receipts of gold at this port during the present year:

The amount of gold shipped from San Francisco by steamers and sailing vessels in the year 1856 to all parts of the world, and manifested at the Custom House, was $50,988,768 50—showing an excess of $6,348,677 97 over shipments of the preceding year. Of the sum stated, $39,704,896 42 came to the port of New York, against $38,730,564 15 in the year 1855. The shipments to England in 1856 were $8,600,000—being in excess of 1855 $3,500,000. The shipments to China in 1856 exceeded those of 1855 some $1,200,000; while to the E. Indies, Sandwhich Islands and Australia, shipments exceed those of any previous year. Thus much for any seeming falling off in the product of gold in California, and this in face of the generally admitted fact that less persons were engaged in mining during the years 1855 and 1856 than in the two years preceding, a great many having turned their attention to mechanical and agricultural pursuits, as being more congenial to their previous habits, and proving highly remunerative. But to compare the manifested shipments of 1856 with those of previous years, I will enumerate them severally, remarking that no reliable estimate can be had of the sums taken away in the hands of passengers or converted into the items of "jewelry," of which you consider the people of California are peculiarly fond:

Total shipment of 1851	$34,492,000 00
Total shipment of 1852	45,587 803 00
Total shipment of 1853	54,905,000 00
Total shipment of 1854	51,429,101 00
Total shipment of 1855	44,619,090 00
Total shipment of 1856	50,988,768 00

The shipments of Jan. and February, 1857, compared with same months of 1856 are as follows: From San Francisco to New York, Panama, and England, January 1856, $3,350,459; for the month of February, $3,395,948; in January, 1857, for same destination, $3,142,661 91; in February, $3,059,900 76; leaving a deficiency in shipments of the present year, as far as received, of $5,52,888 33. While, as you remark, shipments to New York have fallen off, it will be observed that to England they have increased some $500,000. This can be accounted for as regards England—the country through which principal exchanges with Europe are regulated—in this way. A large amount of foreign capital, which has been invested in California, is being gradually withdrawn to make demand for bullion or coin abroad, and to regulate balances of trade, all heavy exportations being now made from England and France direct instead of via New York, as, to a very great extent formerly—the saving of freight and difference in time naturally tending to such a course. This materially affects freights from Atlantic ports to San Francisco, and added to other reasons which I will state, explains why it should be expected that receipts of gold should be diminished; at least until the population of the Pacific coast is largely increased.

Another and principal reason is, that California now produces so many of the staples for which she formerly depended upon the Atlantic States, that her indebtedness to them is much less, and therefore her remittances in payment should be proportionally smaller. For example, in the year 1855 California received 150,000 barrels of American flour, and 67,000 sacks (equivalent to barrels) from Chili. In 1856 from both sources she only imported 40,000 barrels. I might particularize many other articles, but I think this will suffice. That the result of this will tend to the increased wealth of California, no one, I think, will dispute, and it is unnecessary to say more, except that for the manufactures of her sister States she must always be a debtor, or at least until her gold mines shall prove unprofitable to work, which is likely to be a long way in the future. Be that as it may, the yield during the last few months would have been much larger had not mining operations been greatly impeded by the heavy snows in the mountains and mining regions, the loss from which will be much more than made up by the increased product during the three months ensuing. I predict that California will yet become one of the richest and most substantial members of our confederacy.

The *Galaviras Chronicle* of March 14, in congratulating its readers upon the improvement in the business prospects of that locality, says:—

Our merchants have ceased to complain of hard times, and the mining interest is in a flourishing condition—water is abundant, and the prospect at present indicates that that portion of our fellow-citizens will, during the present season, reap an ample reward for their hardy toil.

Quartz-mining, which has so long been unprogressive, seems just now to be exciting a general and very lively interest in this county. Business-men and men of capital no longer stand aloof from enterprises in quartz; and what a few years ago was regarded as an empty bubble, fitted for fools and visionaries alone to engage in, at the present time is looked to by thinking men as the sheet-anchor to the future prosperity of the mining counties. It is true, that this kind of investment does not *always* pay; but it is no less true, that by the exercise of judgment and economy, most of the investments made in this section of the mines, in quartz mills, have paid a large interest upon the labor and capital employed. Generally speaking, when you find a man who has been unfortunate in quartz mining, he is one of that class who has come to the mines, lacking experience, energy, and that sturdy patience which is necessary to produce success in any enterprise. We shall hereafter take pain to inform ourselves thoroughly upon this branch of industry; and we believe

that we shall be able, from statistics within our reach, to induce capitalists to engage in quartz-mining.

QUARTZ OPERATIONS IN BUTTE COUNTY.

The North Californian, published at Oroville, Butte County, speaks thus encouragingly of quartz operations in that neighborhood:

"There is an abundance of quartz in this county, perhaps as much, and as good, as in any part of the State; but the unfortunate operations of '51 and '52 destroyed all confidence in this kind of mining; and until the past year a miner would hardly take a quartz lead as a gift. We believe every quartz company in the county discontinued operations—most of them by compulsion—with the exception of Messrs. Smith & Sparks, who, by their energy and perseverance, have at last very clearly demonstrated that quartz *will* pay. Their success induced others to renew operations, which have generally been successful also. Now quartz property is in greater demand than any other. Five or six mills are in operation in Oregon Township; some of them are on extensive scales. In Spanishtown one or two leads have been opened, on which machinery is being erected. At Wyandotte, Dicksburg, and in the vicinity of Forbestown, quartz operations are being prosecuted, but we do not know how extensively. We hear every day of new ledges that are being prospected in all parts of the county, many of which have changed hands at a very high figure. Our quartz miners are very far behind those of Nevada and Amador counties, where the business has become well established."

JOURNAL OF COPPER MINING OPERATIONS.

MINNESOTA MINING CO.

[The following is the report of this Company for the year ending March 31st, 1857.

In their Annual Report to the Stockholders for the year 1854, your Directors observed, that "the uniform progress which had marked, and the successful results which had attended our mining operations from their commencement in 1848," up to that period, "seemed to render it only a matter of course to anticipate for the following year a material improvement in the production of the mine, and a proportionate increase in the receipts of net profits accruing therefrom." And accordingly, in their next report (for 1855), they had the satisfaction to announce an actual increase *in both* which more than realized their expectations, and "placed the Minnesota, in point of production of *pure metal*, in advance of all other copper mines in this country."

In the same report also, while expressing their confidence in its continued and progressive improvement, they thought it unnecessary and superfluous, after so many years of successful experience, to present any estimates of their own in regard to the future—considering a similar result thenceforth as almost an assured certainty, the only point of doubt or conjecture being as to the probable amount or ratio of such increase from year to year. At the same time they communicated such ample information in regard to the then condition of the mine, and its prospects for the ensuing year (1856), as would

enable the stockholders to form their own opinions and estimates on the subject, and determine the probabilities of the case for themselves.

The undiminished confidence thus felt and expressed by your Directors, and doubtless inspired or confirmed to some extent in the minds of the stockholders by the tenor of the above reports, they are now enabled to state has not been disappointed—but they have the renewed satisfaction of announcing on this occasion, as at all our previous annual meetings, that their reasonable expectations of increase and improvement have been fully realized in the results of the last year's business; our operations being again crowned with a degree of success which ought to satisfy the most sanguine, and convince all, —even those stockholders who became interested at a later date, and at the comparatively high market rates of the past twelve months,—that they have not made a doubtful or unprofitable investment, whether regard be had to the actual returns of the past, or the prospective earnings of the current year.

Our last year's report showed that the Minnesota was then producing a larger amount of pure copper than any other mine in this country—and your Directors feel a degree of just, and they hope pardonable pride in announcing. that it is now the largest producer of *mineral* also—so that, both in mineral and pure metal, its aggregate production is greater than that of any other mine of metallic copper in the United States,—or indeed, as far as at present known, in any other part of the world.

The gross product of the mine for the past year, has been within a fraction of 1860 tons of mineral, against 1434 tons in 1855—being an increase of 426 tons, or about 30 per cent. over the twelve months; and yielding so far as yet smelted, 1½ per cent. more of pure metal than the product of 1855. Your Directors did not, and could not reasonably anticipate an increase for 1856 equal to that of the previous year, when the unexpectedly rich developments at the newly discovered south lode, and the application of steam power to the working of it, suddenly augmented the product to an extent and in a ratio surpassing all our previous calculations; but the actual increase has been 50 per cent. more than the average of the previous four years, and just about what your Directors indicated as probable in their last year's report, "judging from the general appearance of the mine" at that time, "and the amount of mineral exposed to view in the various openings."

The statements submitted herewith will show the market value of this product (including nearly $1,000 worth of silver), to be about $702,000—and the entire expenditures of the year, in round numbers, $357,000—leaving a balance of $345,000 net earnings, equal to $17¼ per share on the capital stock.

That portion of the estimated surplus of 1855 expected to accrue to the benefit of the past year's business, was not fully realized, owing to the sudden and heavy decline which occurred in the copper market last summer, before our previous winter's product was entirely disposed of; but which has since been fully recovered in time to aid materially the sales of our copper now on hand. From the past year's earnings also, some $20,000 have been invested in additional hoisting and pumping machinery, besides several new buildings, and other important and necessary improvements at the mine.

Your Directors therefore, considering the possibility of another decline in the price of copper before our winter's product now on hand at the mine can be brought to market—which may perhaps reduce its value below our present estimate,—do not deem it advisable to divide more than $300,000 from the earnings of the past year, thus leaving ample margin for such a contingency; and this decision they doubt not will be sustained by the judgment of the stockholders themselves, whose reasonable expectations can hardly fail to be satisfied therewith.

It was intended to make this dividend payable in May and November next, at regular semi-annual intervals; but having the past week made a satisfactory *cash* sale of most of the copper on hand, your Directors are en-

abled to anticipate the date of the *first* payment by a month's time—and they have therefore declared a dividend of FIFTEEN DOLLARS per share, (being thirty per cent. on the capital stock,) payable in equal instalments on the 1st of April, and 2d of November next. The transfer books will be closed for the *whole* dividend on the 25th instant, and re-opened on the 2d of April next.

This dividend will make the aggregate sum of SIX HUNDRED AND EIGHTY THOUSAND DOLLARS, (being more than *ten times* the whole amount of capital paid in) divided among the stockholders from the net earnings of the Minnesota mine for the past five years—viz:—

For 1852, ten dollars on 3,000 shares	$30,000
For 1853, twenty dollars on 3,000 shares	60,000
For 1854, thirty dollars on 3,000 shares	90,000
For 1855, ten dollars on 20,000 shares	200,000
For 1856, fifteen dollars on 20,000 shares	300,000
Total	680,000

—a result which cannot but be considered highly satisfactory; and which furnishes a convincing proof that *all* mining enterprises, if legitimate, are not so hazardous and uncertain, nor *all* mining investments, if judiciously made, so hopeless and unprofitable as many are accustomed to regard them.

The usual annual accounts and statements of the Company's business for 1856, in both the operative and administrative departments, will now be laid before the meeting, with such remarks and explanations attached as may seem to be necessary,—together with an elaborate report from Mr. Townsend on the condition and prospects of the works at the mine on the 1st of January last; from all which the stockholders will be enabled to judge of the manner in which their interests have been managed during the past year by their Directors and agents, and of the probabilities of earning as good or a *better* dividend for the year 1857.

Product and value of mineral.—The whole amount of mineral produced or raised from the mine from the 1st of January to the 31st of December 1856, was 3,718,403 lbs.—or 1859¼ tons of masses, barrel copper, and stampings, in the following proportions, viz:—

Mass copper	72½ per cent., or	2,702,051 pounds,
Barrel copper	20¼ per cent., or	750,498 pounds,
Stamp copper	7¼ per cent., or	265,854 pounds,
Total		3,718,403 pounds,

being an average of nearly 155 tons per month for the year, against 119½ tons the previous year—and showing an increase of about 30 per cent. in the aggregate product of the mine, and 6 per cent. in the proportion of mass copper.

The gross value of this product, estimating the net yield of pure copper at 72½ per cent., and the price at our average rate of sales for the past season, will be $701,906.

We also obtained from beneath the stamp-heads, 112 lbs. of *silver* ore, which were smelted at the U. S. Assay office in this city, and yielded in value $986.95, or at the rate of $8.81 per lb.

Cost of production.— The cost of mining, raising, and preparing for shipment the whole product for the year, as shown by the amount of

"Mining contracts and wages," has been	$134,579 60
And the amount of collateral expenditure for all other work at the mine	107,169 45
Making the whole outlay for the year	$241,749 05

—being an average of $20,145 per month, or $130.02 for each ton of mineral produced.

The average number of miners employed has been 225.	
" wages of miners per month	$45·46
" cost of sinking per foot	19 98
" " drifting per foot	7·49
" " stoping per foot	2·63

We did not expect to reduce the comparative mining cost to any con-

siderable extent for the past year, the rates of wages and labor remaining materially the same as the year before—nevertheless, the cost of production *has* been reduced $2,30 per ton, or about 6 per cent. below that of 1855.

Shipment, yield, and proceeds of Mineral—The whole quantity of mineral forwarded from the mine the past season, including that left over at Ontonagon the previous fall, was 3,580,051 lbs. or 1790 tons—all of which was smelted at Detroit as heretofore, and yielded 2,593,246 lbs. or 72½ per cent. of ingot copper. This increase in the average yield over the two preceding years, is doubtless due to the larger proportion and superior purity of the mass copper of last year.

Of these receipts, 2,074,686 lbs. have been sold and delivered to the 1st instant, realizing the gross amount of $532,735.21—or an average of 25.67 cents per lb. The balance of 518,560 lbs. then on hand, and which has already been partially disposed of at the present advanced price, will increase our average rate of sales for the whole product to a fraction over 26 cents. This is still nearly 1¼ cents per lb. less than our average sales for 1855,—which is accounted for by the temporary decline in the copper market already alluded to, and which has therefore reduced the year's avails some $30,000 below what they would otherwise have been.

Total expenditure, and net earnings.—The total amount of expenditure, including the cost of production, and all additional charges for carrying on the Company's business operations the past year, has been as follows, viz.:—

For mining cost (as per statement above)	$241,749 05
For transportation account	42,271 56
For smelting account	34,932 75
For interest and commissions	15,494 41
For insurance account	10,431 26
For general expenses	11,662 72
Total expenditure	$356,541 75
The gross value of the whole year's production was shown in a previous statement to be	$701,905 77
The above shows the total amount of expenditures for the same period, including mining cost and all charges, to have been	356,541 75
Making the nett earnings for the year	$345,364 02

In remarking on the statement of expenditures in their last report, your Directors anticipated a reduction thenceforth in the comparative cost of our transportation—and this has been effected the past year to a considerable extent, although the full advantage expected to be derived from the harbor improvement at Ontonagon, cannot be realized until its completion. The work however is progressing favorably, and the harbor is expected to be open in the spring for all vessels drawing not more than nine feet of water. This result, if realized the ensuing summer, will also enable your Directors to come to some decision on the question of erecting smelting works, or at least to make some definite communication on the subject to the next annual meeting.

It will be observed that all the other items in the foregoing statement (except smelting) are *less*, in proportion to our production and sales, than for 1855.

Treasurer's Account.—The Treasurer's account has been audited by the Committee on Accounts, in connection with the vouchers produced for every item of his debits and credits, and certified by them to be correct. The following abstract shows his receipts and disbursements, and the balance on hand in cash and bills receivable on the 1st of March instant, viz.:—

Receipts.

To cash balance on hand March 1st, 1856	$23,699 64
To bills and debts receivable, from 1855	120,479 87
To sales of copper from 1855	30,683 91
" for 1856, to date	532,735 21
To sales of silver "	986 85
To bills payable discounted	56,769 58
	$765,355 06

Disbursements.

By bills and debts payable, for 1855	$93,137 16	
By dividend, $10 per share, "	200,000 00	
By agents' drafts for wages, supplies, etc., and payments on sundry other accounts as per vouchers, No. 1 to 1289	414,264 68	
		707,401 84
Balance on hand in cash and bills receivable, March 1st, 1857		$57,953 22

The above balance, with the avails of copper now on hand, will furnish the Treasurer with ample means to meet our present outstanding liabilities, including the dividend due on April 1st.—while the balance of mineral to come forward this spring will provide for the dividend of November 2d.

Mineral on hand.—The following statement shows the whole quantity of mineral on hand (partly at the mine, and partly at Ontonagon in readiness for shipment) on the 1st of January last, and also on the 1st of March instant:—

Mineral on hand January 1st, 1856, (as per last report)	418½	tons.
" raised from January 1st to December 31st, 1856	1859½	"
	2278	"
Mineral forwarded from Ontonagon in 1856	1790	"
Mineral on hand January 1st, 1857	488	"
" produced in January and February, 1857	307	"
Amount on hand March 1st, 1857,	795	tons.

The gross value of this mineral on the ground, estimated at the percentage yield of last season, and at the present market price of copper, would be about $334,000—but deducting the probable cost of transportation, smelting, and all other charges on its conversion and sale, the net value may be fairly estimated at 24 cents per lb.—amounting to $276,660.

Property at the Mine.—Mr. Townsend's returns and accounts have been received to the 31st December last; and together with the inventory of property of all kinds on hand, and debts payable and receivable outstanding at that date, show the following statement of the Company's property at the mine, viz.:—

Surface improvements, consisting of buildings of all kinds, roads, docks, clearings, &c., estimated at cost	$64,298 00
Personal property, including engines and machinery, tools and implements, live stock, vessels, boats, &c.	77,874 00
Supplies and materials of all kinds, at cost and charges	83,785 00
Debts receivable	1,945 00
Cash in agent's hands	16,732 10
	$244,634 10
Deduct amount of indebtedness for wages, &c.	126,830 07
Surplus of property at the mine	$117,804 03

By comparing the foregoing statement with a corresponding one in last report, a considerable increase will be remarked in the respective amounts of "improvements" and "personal property"—a new store and office for the Company, houses for agent and minister, and several other new buildings having been erected during the year—also, a new steam-engine of 100 horse power, located at shaft No. 6, but intended to work besides Nos. 1 and 2, and a new shaft to be opened east of No. 6—and which is expected materially to assist the production of the present year, especially from the eastern part of the mine, now improving very rapidly, but from which little mineral had heretofore been taken.

General Statement, March 1, 1857.—The general state of the Company's affairs, and the total amount of its surplus assets (exclusive however of its real estate, and the extensive and valuable permanent improvements thereon), will fully appear from the following schedule of resources and liabilities, made up from the foregoing statements and the Company's books on the 1st of the present month, viz:—

Resources.

Mineral on hand at the mine	$276,660 00
Personal property and supplies at the mine	161,659 00
Ingot copper on hand	142,604 00
Bills and debts receivable	189,341 15
Cash in treasurer's hands	14,563 42
Cash in agent's hands at the mine	16,732 10
	$801,559 67

Liabilities.

Bills and debts payable	$115,994 59	
Indebtedness at the mine, January 1st, 1857	126,830 07	
Mining cost for January and February, 1857	42,000 00	
Dividend declared for 1856	300,000 00	
		584,824 66
Total surplus assets		$216,735 01

By comparison with the corresponding statement in last report it will be seen, that after providing from the net earnings of the past year for a dividend 50 per cent. in excess of that for 1855, the Company has still a larger surplus of available property by some $26,000 than was reported at the close of that year.

(To be Continued.)

The Lake Superior *Miner*, of March 21st, gives the following information, in regard to the recent operations in that region:—

The *National* is the first mine east of the Ontonagon river. It is opened and mainly worked by adits, driven into the western spur of the bluff upon the conglomerate vein—the same as that of the Minnesota, Rockland, Superior and Flint Steel Mines. The lower, or No. III, is the present working adit. The mouths of the other two are closed for the purpose of turning the warm air of the mine through the No. 2 shaft, to prevent the pump from freezing. A large building has been erected at the mouth of this adit, which affords abundant room for a warming house, a mineral house, and in the upper story a changing house. It is warmed by a large stove, which completely disposes of all the ice by which they were formerly troubled, and ventilates the pump shaft with warm air, so that it is kept from freezing without difficulty in any weather. It also contains in the mineral house, an excellent crane and weighing apparatus.

They have put up a clever portable engine so as to work from both shafts, which seems to be doing fair duty. It lifts its own water several hundred feet, clears the mine of water by lifting it to the lower adit, and brings up some 250 kibbles, by the consumption of a cord of wood per day.

The *Company* have had for several years a large vertical high-pressure engine of the same pattern and size as the Minnesota No. 3. This will probably be put up during the approaching summer.

In the underground operations they have driven a level below No. III adit, which is connected between the shafts, and is now going east. Both shafts are sunk below the level of the proposed adit No. IV, which is a lift below the last-named level, and two lifts below adit No. III. They will next month commence to drive for connection between the shafts at this low point, and east of No. I shaft.

The last-named is the most eastern shaft. It is sunk 170 feet below III adit, and nearly 500 feet from the surface. They have driven east from it in No. III adit, 230 feet; in IV level 140 feet.

The proposed new adit would pass under an immense back of ground. But we do not understand that they have as yet determined to drive it.

The late improvement in the National has been almost entirely in the lower and eastern workings. In the back of No. III, about 100 feet east of No. 1 shaft, they have a mass estimated to weigh 10 or 12 tons. It shows superficial dimensions amounting to about 180 feet. Its thickness is somewhat uncertain, but a cut in one place shows about ten inches. It is a continuation of a mass from which some ten tons have been taken. A good mass seems to be coming up in No. IV drift, near its present end. At the bottom of No. 1 shaft the drilling has been stopped in several places on account of copper. This indicates well for the new level which is to form a part of the proposed adit.

A remarkable change in the character of the vein is met with in the ground lying to the east of No. 1 shaft, below III level. The vein becomes much larger, being from 2 to 3, or 7 or 8 feet wide, and carrying a horse of trap in the middle. It carries a great deal of copper, which is found almost entirely above the horse of ground, and near the hanging wall—contrary to the general law of native copper veins. Sheets of copper extend through this intermediate trap, and the upper part of the vein contains an unusual quantity of calx spar, with considerable laumonite. The enlargement, or "leader," as the ore miners call it, extends as far east as they have driven. It presents something of the appearance of a vein which had been re-opened after the original deposit. It is showing more small copper than has hitherto been found in the vein.

They are now working about 50 miners—raised 20 tons in January and 12 tons in February. Much of the latter month was consumed in getting out a mass which they are now cutting up, and which will aid them in making a very respectable product for March.

The *Minnesota* raised in February last 302,445 pounds, or a little more than 151 tons of copper.

The *Rockland* product for the same month was 60,511 pounds—more than 30 tons. This is, of course, exclusive of stamp work, as the mill has been running on Minnesota rock. It will commence on Rockland work sometime in April.

The *Norwich* got out ten tons in February, and will probably get out the same during the present month.

THE GREAT MASS.

Since our last we have been twice into the Minnesota Mine to look at this piece of copper. A few tons have already been taken from it, and there are some thirty men at work cutting it up; more parties will be put on soon. The lower end of the copper was raised by the powder from the rock in which it was enclosed—the upper end being very little disturbed. This leaves it inclining but little from the horizontal, and in an excellent position for cutting to advantage. They are cutting in some ten places, two of which are already into where the copper is *five feet thick*. Another is four feet and a quarter. Eighteen inches farther will bring one of the cuts to where the copper is *seven and a-quarter* feet thick. Its greatest thickness is between 8 and 9 feet, but the cuts driven from the edges very soon reach the thickness of 3, 4 or 5 feet, and its average thickness will be from three and a-half to four feet. Its greatest length is 46 feet. Greatest width, 18 1-2 feet. We made the following measurements of its width at several points—in feet and decimals—11—12.5—18.5—16.2—12.7—10.9—6.—showing a mean of about 12 1-2 feet. We cannot think its average thickness to be less than 3 1-2. These dimensions give it a cubic content of about 2,000 feet, and this amount of pure copper will weigh 549 tons.

Unless it should prove to be a great shell enclosing rock, its purity must be very high, probably more than 90 per cent. And we think there is no ground for such an apprehension. If it is 91 per cent., and this is not a high estimate for such a mass, it contains about 500 tons of pure copper, and will be worth, when prepared for the market, about $300,000.

But the great mass is a small part of the copper now in sight in its imme-

diate vicinity. About a hundred feet to the east, a series of monster masses of enormous size are now being stripped and followed into the conglomerate, the aggregate weight of which, including the great mass, will, in all probability, exceed the total product of the mine for the year 1856. They have just exposed a large opening going south into the conglomerate, which they are about filling with powder. This blast may make new discoveries, for which we anxiously wait, and the result of which we hope to give in another number. The disclosures of the last few days are immensely important. It is perfectly safe to say that there are at least *two thousand tons* of copper in sight within a few feet of the points which we have described.

AN AUSTRALIAN COPPER MINE.

The Burra Burra Copper Mine in Australia, cost its shareholders for land and total working expenses up to the dividend paying point $61,150; up to the present time only seven acres of the property have been worked, and from the proceeds of this tract $2,156,875 have been paid in dividends, and the mine is now going on at the rate of $433,270 net profit half yearly.

THE GILA COPPER MINES.

These mines were discovered in the early part of 1856 by Richard Halstead, well known in the Gadsden purchase as an indefatigable and able prospector. They are situated about twenty-four miles from the junction of the Gila, with the Colorado, on the left bank, southern side of the Gila, and two miles from the river. Immediately after the discovery, Mr. Halstead communicated the fact to Messrs. Hunton and partner, the well-known firm at Fort Yuma, who, with Lieut. Maury, of the United States Army, advanced sufficient funds to thoroughly prospect and open the mines.

The result, thus far, has justified all their expectations. Several experienced Mexican miners, under the direction of Mr Halstead, have been employed for the past six weeks with the most flattering success—a shaft has been sunk some thirty feet, and a lode of copper ore about fifteen inches in thickness is being steadily worked. Several other veins, one certainly much larger than the one mentioned, have been opened sufficiently to test their richness and probable extent. An assay by Wass, Moliter & Co., gave of metallic copper a percentage of fifty-six one-hundredths, and two others by Justh & Hamilton gave fifty-seven and fifty-five per cent.

The great advantage in the location of this mine must make it immensely valuable—the ore or smelted copper can be transported on flatboats down the Gila to the junction of the Colorado and Gila, whence it can be carried by steamboats now running on the river, and delivered on board vessels at the head of the gulf at eighty dollars a ton, a rate which would defy competition from any distant part of the Gadsden purchase. It is proposed immediately by the present owners of the mine, to put a limited number of shares into the market upon the shipment of the first ore. This account comes from a well-known gentleman who recently visited the mine.

JOURNAL OF SILVER AND LEAD MINING OPERATIONS.

ON THE PROCESSES OF REDUCING SILVER ORES BY AMALGAMATION—BY EVAN HOPKINS, ESQ., F. G. S., ETC.

Among the various operations of metallurgy, the process of amalgamation forms one of the most interesting, both from the value of the ores operated

upon, and the nature of the chemical affinities which are brought into action. This process of saline decomposition with sulphurets, and amalgamation with quicksilver, is never resorted to when the ores contain a large proportion of lead ores, and more especially in districts where fuel is obtainable at a cheap rate, inasmuch as the minerals can be smelted, and the silver extracted by cupellation.

In Mexico and South America, the argentiferous formations predominate in what are technically called "dry ores"—viz., argentiferous pyrites, metallic silver, red, gray, and antimonial silver ores, with blende, in quartz and slate, and but sparingly impregnated with lead ores. Hence the cause of the process of amalgamation being adopted, and the smelting process unavailable in such mineral districts. However, it must be borne in mind that, be the process of reduction what it may, it is attended with a certain amount of cost; consequently, the ore, to pay for such a treatment, must be brought by dry picking, or by stamping and water concentration, to a sufficient value to pay for that cost, and to leave besides a profit on the whole operation.

In entering into this subject, I am not guided by others, or any scientific works, but by actual operations carried on during many years. I have had a very considerable practical experience in these matters, not alone as a mere superintendent, but also as one who has been often obliged personally to attend to the details of the respective departments, and to teach the natives how to do their work. I have been compelled to attend to the underground works, as well as to the dressing, assaying, and amalgamating departments, and have had to erect all the works besides, without the aid of the usual qualified agents, for some years in the Santa Anna establishment. It will, therefore, be observed, that my opinion on such questions is not founded on mere laboratory experiments and the statements of others, but on large operations carried on by myself. Indeed, when I took charge of the silver mines of Mariquita in 1837, I was without a mine captain for upwards of 12 months, and also reduction officer, engineer, or even a doctor, in a hot and very unhealthy locality.

I found the mine poor, apparently worked out, badly ventilated, dilapidated, and the machinery in complete ruin from various causes. Nevertheless, the concern was taken in hand. I made new discoveries underground, set all the bargains myself, made all the plans and sections, surveys, erected new surface works, pumping machinery, stamping mills, furnaces, barrel and grinding mills, in a more convenient locality (which are still at work); and, in short, brought the concern, with but little assistance, into a safe, systematic, and profitable state—in which condition, with a large amount of ore in reserve, I left in 1842.

I am happy to state that this establishment is now one of the richest silver mines in South America, and the discoveries I then made underground are still improving. I mention these particulars merely to show what foreign managers are obliged to do occasionally, and that they must thoroughly understand their business, and attend to it themselves, in order to conquer the many difficulties and obstacles they have to contend with in foreign countries. After an establishment is well formed, and the agents trained to their respective departments, a good accountant may then act as a manager with apparent credit.

In Mexico, at the commencement, the English companies failed in introducing the Freiberg system of amalgamation, evidently from the want of persons competent to carry it into effect, and they continued the native method—the *patio*. In South America we succeeded in establishing the barrel process at starting; but in order to obtain the relative merits of both the Freiberg and Mexican process of amalgamation, we had a certain quantity of silver ores treated in both ways. It was found that the loss of silver and quicksilver was excessive by the patio, the process slovenly and very slow, and irregular in its results; whereas, the loss of quicksilver by the barrels was only 2 lbs. per ton of ore treated, and the loss in silver from 10 to 12 per

cent., and the product obtained with greater dispatch and regularity. The cost of treatment by the former was quite as much as that incurred by the latter, with all its machinery. Hence the barrel process was preferred, and continued at Mariquita and Pamplina.

The barrel process of reducing silver ores may be thus described:—The ores, after having been concentrated to a certain value (say 100 ozs. per ton), and reduced into very fine powder, are spread into flat heaps, and dried and mixed with ground common salt. The mixture is then gradually calcined in reverberatory furnaces, and the chemical action commences. The sulphur of the sulphurets evolves, and contaminates the whole mass. A stream of air is then admitted in sufficient quantity to convert the liberated fumes of sulphur into anhydrous sulphuric acid. The salt in the mixture becomes by this element decomposed. The soda unites with the sulphuric acid, forming the sulphate of soda. The chlorine is liberated, and, having a strong affinity for the silver, combines with it, together with the other metals in the compound, and thus forms chlorides. The efficiency of this process depends on *double* decomposition, acting at the same instant of time—*i. e.*, the affinity of the acid for the soda, and the affinity of the chlorine for the silver. Hence the importance of perpetually raking the mixture in the furnaces, to insure the decomposition of the salt, and the constant contact of the re-agents in the mixture, to convert the sulphurets into chlorides. This process being completed, the calcined and decomposed ores are re-ground into impalpable powder in flour mills, and then put into rotating horizontal barrels, with water, iron scraps and quicksilver, wherein the compounds are thoroughly mixed together for about 20 hours.

The chemical action which ensues may be considered as follows:—The mixtures are composed of the ground matrix, with sulphates of soda, chloride of silver, and other metals, with an excess of acid. The sulphuric acid combines with the water, and by degrees, as the barrels turn round on their axes, generates great heat. The iron then decomposes the water by combining with its oxygen, and the hydrogen as evolved. The barrrels become highly charged with this gas in a very few hours; the chlorine of the chlorides leaves the metals with which it was combined; these are immediately absorbed by the quicksilver, whilst the two gases unite and form hydrochloric acid. After the usual period allowed for the operation has elapsed, the mixture is further diluted, and the quicksilver is discharged, conveyed into strong bags, then filtered, and the amalgam distilled in the usual way.

The sulphate of soda is sometimes preserved, and also converted into a carbonate of soda, but not in the interior of South America, as it could not be disposed of at a profit. When the argentiferous ores contain payable quantities of copper and gold, the first metallic precipitant put into the barrels is copper, which is taken out and replaced by iron after the quicksilver is discharged.

The copper is obtained by precipitation from its solution in the barrels or separate tanks. The gold is again parted by dissolving the metallic silver in acid, leaving the gold as a residue of brown powder, which is filtered, washed and melted. The silver is converted from its solution into a chloride, then decomposed with weak acid and zinc, and the separate metals delivered in ingots.

Such is a brief outline of this old-established process, as carried on in America on the large scale. The following will give an idea of the patio process of reducing silver ores.

The ores, after being selected and brought to a given value, are ground to the consistency of fine mud, and spread out into large flat, circular heaps, on pavements (called in Spanish *patios*), after having been well mixed with common salt. To these flat heaps (called *tortas*) are added given quantities of pulverized and calcined sulphurets of copper and iron (converted into sulphates in closed ovens), which, after being thoroughly mixed with the ores, generates considerable heat. The chemical action then commences. By the action of the moisture of the mixture, the sulphates are decomposed and dissolved, and the sulphuric acid is set free. The sulphuric acid thus liberated rapidly

decomposes the salt, and combines with the soda; whilst the chlorine of the salt having a stronger affinity for silver and other metals, combines with the latter, and forms chlorides of silver, copper, and iron. When the action happens to be too intense, a little lime is added to cool the mixture, by uniting with the excess of acid, and forms sulphate of lime. After the heaps have been well mixed and kneaded by the feet of mules, quicksilver is sprinkled at intervals over the mass, and is thoroughly incorporated with the mixture by constant treading of the animals, until the testing (*tentaduros*) indicates that all the chloride of silver is reduced into amalgam, and the latter found in a proper consistency. These heaps are then washed in the *lavadero*, in large dolly tubs, with an excess of water. The refuse is carried away with the water, and the charged quicksilver is left behind in the tubs, with some of the heavy sediment. It is then filtered through strong canvas bags, and the amalgam distilled in retorts in the usual way.

The cost and efficiency of the above processes depend much on the arrangements of the works and the management. The actual cost of the reduction process at Santa Anna whilst under my superintendence, from 1837 to 1842, was on an average $22 per ton, including $11 for salt; and the losses in the treatment about 10 per cent. of silver, and 2 lbs. of quicksilver per ton, including the losses in distillation and refining.

LEAD AT GALENA—MOVEMENT OF MANUFACTURERS.

The following table exhibits the amount of lead brought to Galena, and the price, from 1842 to 1856:

Years.	Pig Lead.	Total lbs.	Price.
1842	447,909	31,353,660	$2 24
1843	559,261	39,148,270	2 34
1844	624,672	43,727,040	2 60
1845	778,498	54,494,360	2 69
1846	782,403	51,269,210	2 99
1847	772,656	44,085,920	3 17
1848	681,909	47,737,830	3 24
1849	672,934	47,025,380	3 67
1850	568,589	33,188,050	4 20
1851	474,015	38,123,059	4 18
1852	408,628	23,663,960	4 12
1853	425,814	29,306,980	5 50
1854	423,617	29,633,160	5 50
1855	430,365	30,125,550	5 75
1856, estimated 25 per cent. less than 1855.			6 50

The manufacturers of white lead, lead pipe, shot, &c., have petitioned Congress to place the raw material, pig lead, on the free list, and the committee have reported favorably upon their petition. The petitioners argue that the production of lead in this country has largely decreased, notwithstanding an increase of 100 per cent. in price, and that about the entire production is consumed at the West, so that the introduction of foreign lead free would be no detriment to the native miner. They also argue that the 20 per cent. duty on pig lead entirely closes the market of Canada, the West Indies, &c., against our white lead, shot, lead pipe, &c., these markets being monopolized by the English manufacturers, who have no duty to pay on the raw material.

In 1854 there was imported into the single port of New York 55,945,900 lbs. of foreign lead—more than the Galena mines ever produced iin any one year. Notwithstanding a great advance in price, the annual production of lead has greatly fallen off since 1847—the miners having been drawn off by the stronger attractions of the California placers: and, unless the business of lead mining should be prosecuted with more vigor from this time forward, it is believed that in 1857 the western manufacturers of lead will have to procure a portion of their staple from imported foreign lead in the Atlantic cities. We have been gratified to observe during the last year, however, that the owners of mineral lands in Wisconsin and Iowa have engaged in mining with renewed energy: and, as the supply is abundant, we presume the market will show a considerable increase in the product of the present year. With such an abundance of ore of the richest quality, scattered through several States, we ought not to be dependent upon foreign countries for lead.

QUARRIES AND CLAYS.

PREPARATION OF VEGETABLE FUEL.

Since several years it has been a subject of study to many chemists to produce different preparations from the vegetable fuel called turf.

Most have succeeded in obtaining from the turf a variety of empyreumatic oils, as lubricating oil which has been applied to various purposes, besides this, a small quantity of paraffine is obtained, from which very fine candles are made which resemble much those of sperm. And finally, a residue of a kind of very porous and well burning coke is obtained.

These products, however, are but of small value against the value of the turf itself in those countries where fuel is scarce and dear. It is used with a greater pecuniary advantage as a fuel; so, for instance, all the locomotives of the railroads in Bavaria are fed with dried turf, and as these railroads pass through a good many fields where this material occurs abundantly, it is evident that this employment is advantageous.

However, the turf requires a good deal of time and good weather to become well seasoned; it requires very large storehouses to keep it dry, and to store it for such seasons when it cannot be dried. The volume of the common turf is very considerable compared with its power as a fuel, and even to make use of it as a fuel, it demands a great deal of labor to the fireman.

Besides these inconveniences, the best seasoned turf has the property to be very hygroscopic, a quality which lessens much its heating power. It contains 30 to 40 per cent. of water, which, on being evaporated when brought into the fire-place, absorbs great quantities of heat which escapes with the steam through the chimney.

The attempt to reduce the volume of the turf, to make it less porous, and hence less hygroscopic, has been made frequently, but many times with questionable success. The administration of the Bavarian railroads have caused a great many experiments to be made: they have chiefly applied themselves to effect the desired end by pressing the turf by means of powerful hydraulic presses, but found that this was too slow and expensive.

In the regions of the river Aar in the western part of Switzerland, there are very extensive turf fields, so extensive that they are almost worthless, though the turf be of good quality. But as there is very little manufacturing industry the value of this voluminous fuel is very limited.

I have seen there an establishment not yet at work, which has been formed by a joint stock company with a capital of 150,000 francs, and which proposes to manufacture from the raw turf a kind of fuel which has only $\frac{1}{6}$th of its original volume, and is so very hard and compact, and without the property to absorb moisture from the air, that one may indeed expect the most favorable results from this enterprise, as this prepared fuel may well support the freight to places where fuel is more in demand.

The means of making such a beautiful condensed turf as is shown by samples, are very simple; they consist simply in reducing the turf to a fine pulp, to strain the pulp through a fine sieve, to dilute it with sufficient water to allow the earth and fine sand mixed in the raw turf, to deposit themselves at the bottom, and to conduct the pulp in large reservoirs where the water goes off, and to mould the very thick pulp like bricks without pressure, and finally, to dry these bricks first in the open air and then in a hot place.

I will try to describe the machinery which is nearly completed for that purpose.

To render the transport of the raw turf to the place where it is manufactured as cheap as possible, canals are cut in the ground, leading from the places where the turf is dug to the place where it is manufactured; the raw

material is then very easily conveyed to the place where it is wanted. Behind the working machinery, and reaching into the boats in which the material has been deposited, goes a hoisting-machine which, with the help of a man, carries the material from the boat to an elevation of about 20 feet, where it drops its charge into a sort of a funnel.

Below this funnel, are two cylinders armed with nails or spikes standing out from the circumference; these being placed and contrived so as to move in opposite directions, tear the soft and wet turf into small pieces.

These small pieces fall down upon another cylinder which revolves also in a large flue which forms a continuance of the funnel. This cylinder at its circumference is armed with a large number of curved blades of steel, which strike in their revolution against one projecting horizontal blade, with which they effect something like the cut of a pair of scissors. Above this cutting apparatus a stream of water is introduced from both sides of the funnel, so as to clean the cylinder and to suspend the particles of the turf so as to form a pulp. From beneath this second cutting cylinder, the funnel is divided in two branches which lead the pulp in two cylindrical boxes. These are made of sheet iron, and are each formed of two cylinders, of which one is placed within the other, so as to leave an empty space of a few inches between. The surface of the inner cylinder is perforated by small holes, a perpendicular axle bearing four wings is moving rapidly in this inner box, and causes by its motion all the fine particles of the pulp to go through the above-mentioned small holes, whereas all coarser parts remain in the interior and may be removed from time to time. The outer box, of course, serves as a receiver for the final pulp, and communicates by pipes with very large vats, which receive the pulp at about the middle of their height. In these vats there are also perpendicular axles and wings which keep its contents in motion; to falicitate this motion a certain quantity of water goes through the axle and is introduced from below. At the upper rim of these vats a circular receiver surrounds the vat, into which the contents of the vat overflow constantly. The chief purpose of these vats is to dilute the pulp sufficiently to cause the sand and earth to separate from the vegetable matter, and to deposit itself at the bottom.

From the outer rim which receives the overflow, a series of flues lead the thin pulp into very large reservoirs dug in the ground, where the excess of water partly evaporates and partly goes through the bottom. These reservoirs are about 3 feet deep, 50 feet in length, and 25 breadth.

Round these reservoirs are very light wooden buildings with shelves, for the purpose of receiving the pieces of manufactured turf, and of drying them by the common draft of the air. These pieces are made from the pulp after it has taken sufficient consistency in the reservoirs, and are formed exactly as bricks are formed from clay.

After the turf bricks have sufficiently dried in the air, they are removed to a dry-room, where they acquire full hardness, so as to be ready for sale.

The whole machinery is moved by a steam engine of 15 horse-power.

What amount of manufactured turf will the power of 15 horses furnish? This is now the great question!! I shall not anticipate the soon expected results, by any opinion; but the samples of this new preparation are so fine that they excite the most partial expectations, and the whole business is well worth the attention of all who care for improvements in the arts.

Close to this establishment, there is an opposition one. There the newly dug turf is simply ground between two stones, like those used for grinding fruit for the manufacture of cider. The paste which issues between the two stones is immediately formed into bricks, and simply dried in the open air.

I do not know what amount of power is consumed to produce a certain quantity of manufactured turf. The samples I have seen of this preparation keep the mean between raw turf and the produce of the above described

establishment; they are still porous but tolerably hard, and may as a fuel answer tolerably well.

In the neighborhood of these establishments I visited, also, some old friends who are paper manufacturers. There I saw a new construction of steam boilers, manufactured by Bryan, Donkins & Co., London, which I will describe as a curiosity. The boiler has two interior fire-places at each opposite end of the cylinder, which is the shape of the boiler. These fire boxes, however, are rather small, and take up only one-fourth of the circular bore of the cylinder; they are exactly opposite to each other, so that the flames go in opposite directions and meet in the middle of the boiler; then both currents mix and are directed towards the bottom of the boiler; on the bottom the flue turns on the other side of the boiler, and divides itself again in opposite directions, and goes through a system of pipes which issue both at opposite ends of the boiler, from where the gases of combustion are again reunited in the chimney.

Machinists are as fond of, and as subject to, fashion and change of dress as ladies; in this instance, at least, I cannot discover what advantage is gained by making complicated what we know to answer better if made simple.—*Charles Schinz.*

MISCELLANIES.

ILLUMINATION OF MINES.

In a lecture delivered at the Government Schools of Mines in London, Mr. Warington Smith observed that the mode of illumination differed considerably in various localities; in Sweden and Norway they used torches, which were made of pitch, and in the copper mines of Roraas, and those of silver at Kongsberg, fagots made of split deal were employed; these however could only be used where there were large excavations and good ventilation. The most general method of lighting up mines was either by lamps or candles, and there was a considerable variation in them in the different districts and several countries where they were employed. In many parts of Styria and Hungary the candles were so large that there were not more than 6 to the pound; in the mines of Cornwall, France, and the Alpine districts, they were generally from 10 to 18 to the pound; in Saxony there were as many as from 30 to 50, while in some of our own collieries the number was from 50 to 60 to the pound. In former times it had been customary in collieries to examine by a candle whether any fire-damp existed, and according to the flame of the light, and the appearance of the wick, the workmen could judge of the danger; there was, in this mode of testing, a great risk, and since the invention of the safety-lamp, candles in collieries had, to a great extent, been superseded. When descending the mine, it was generally the custom of the miner in Cornwall to place his candle alight in a piece of clay; this was carried in front of his hat, and when at work against the level, or wherever he might be working, the clay formed a holder, and adhered to the wall, and this practice was sometimes adopted in Mexico. In the Bath and Bristol collieries they generally used a small holder, about 5 or 6 inches in length, terminating in a point; this in general they stuck in some crevice of the working, and by its light were enabled to carry on their labors. In Mexico they had rather a cumbrous machine of wood, though it was not without its utility; in the lower part they could carry a supply of candles; at the top was a species of square box open in front, in this they could place the candle, and should they feel any

draught on descending, this could be easily turned so as to prevent its being extinguished. Lamps in France were used in general by the inspectors, and those who were employed in tramming and wheeling; it was generally considered that as a medium of illumination oil was preferable to candles, it being so much more economical, and there was this great advantage, that lamps could be so trimmed as to give the requisite amount of light wanted.

A German, WEHRLE, had made some very accurate experiments on gases and foul air, and lamps were found better in levels and galleries which were open to the air, where there was generally a great draught to be encountered; these were likewise found more useful in wet places, where a candle was liable to go out. The same observation would apply to those mines where they employed a machine to lower the men. In France, to the end of the lamp, which was generally open, they had attached a long pin, which could be inserted in holes in the workings, in a similar manner to that practised in the Bristol and Bath collieries, as had been previously described. In the Belgian collieries, in the district of Mons, where the ventilation was good, and there was no fear of fire-damp, the lamps used were of a simple construction, as would be seen from the specimen on the table before them. In Prussia, and some districts of the Hartz, something similar to the old Roman lamp was in general use; this had a small chain affixed to it, terminating in a hook, which when they were passing from one place to another, could be carried on the thumb. In Hungary, where a great number of workmen were employed, the mode of lighting the mines was a serious item in the cost; in some cases, they used vegetable oil, such as rape and linseed, but some of the lamps were so constructed that grease and tallow could be employed; and, in some instances, horse fat was used. The agents in these mines use a precisely similar lamp to those of the workmen, but it was furnished with a better reflector, and generally made of more costly materials. The Scotch, they were aware, were a very economical people, and the lamps they used were very small; the cost of the lamp would be about 1½d., and the oil consumed in a man's daily labor would not amount to more than that sum. In Saxony, the lanterns could either be used for candles or lamps; in general they were furnished with reflectors of some metal, and having a handle which could be suspended in front of the dress, they were very convenient to carry: those carried by the superior officers had in general a brass reflector, and, in some instances, a glass shade, which could be removed when not required, so secured at the back of the lamp as not to be liable to accidents. When they calculated the number of persons there was working underground, both in our metallic mines and collieries, they would see that if only they effected a saving of ½d. per day on each man's light, it would be a great diminution of the expenditure. Previous to the introduction of the safety lamp, many valuable seams of coal had to be abandoned, it not being considered safe to work them. In former times, it was considered a great recommendation to a collier if he could work in the dark, and, in some cases, the steel mill was employed; this was a disc, which turned round sharply, a flint was applied to it, and from the sparks emanating the laborers proceeded with their work; but, even with this imperfect light, explosions were often occurring. In South Staffordshire, men, technically called fire-men, were employed to creep in with a candle (which was fastened at the end of a long stick), in case there should be any explosive gas to fire it, and from this practice many casualties had happened. Several plans had been proposed for the lighting of collieries —one had been by reflectors from the surface; another, by the agency of the electric light; while some had advocated the employment of a large quantity of fixed lights. One gentleman had suggested that a gas-making apparatus should be erected at the surface of the coal mine, the gas to be carried down by a pipe, together with a number of auxiliary pipes; but this scheme had been declared impracticable.

There had been great disputes as to who it was that first invented the safety-lamp; in general it was ascribed to Sir HUMPHREY DAVY; but about

the same period, one of a similar nature had been invented by G. STEPHENSON. Dr. CLANNY brought forward one soon after; and, for a considerable period, there was a warm controversy as from whom the idea had at first emanated. The lecturer then described the lamps, pointing out the difference in the construction, and ably expatiated on their liability to accident from fall of rock, carelessness, &c.; in many instances accidents had arisen from the miner's tampering with the lamp, and opening it in order to obtain a better light. In the north of England STEPHENSON's lamp, or, as it is called, the "Geordie," was most in favor with the colliers. Above the basin in Dr. CLANNY's lamp there was a glass; the colliers, however, had an objection to this, as they were afraid they could not trust it, being fearful that it might be burst with the heat. Although the lamp he held in his hand had been cracked, and had been used in collieries since, the heat had no perceptible effect on the glass. It was one great desideratum in safety lamps, they should not only be secure, but that, at the same time, they should be of as small a dimension as possible, and easily portable. Messrs. UPTON and ROBERTS had invented a very ingenious lamp, but the great objection to it was that it was cumbrous, and consequently was not of so great utility for the purposes of locomotion as one of a lighter kind. In Belgium they only allowed four kinds of lamps to be used—these were those of Sir HUMPHREY DAVY, MM. ELOIN, BOTY, and MUSELER; and although there had been 18,000 lamps of the last-named gentleman manufactured in Belgium, hitherto not a single accident has been traced to it. This lamp was furnished with a chimney, and appeared to have given great satisfaction, and been generally approved of in Belgium. He next adverted to a lamp invented by Mr. B. BIRAM, Lord FITZWILLIAM's agent, which promised to be of great utility, though, as yet it was not generally known, nor had it been extensively used.

In conclusion, Mr. WARINGTON SMITH observed, that with these lamps great care should be exercised by all concerned; more stringent regulations were being adopted in our collieries, and as the laborers progressed in education they would be alive to the dangers which, in too many instances, arose from their own carelessness, aided as it was by a lax supervision on the part of some of the overlookers; and it was to be hoped, that although it could not be supposed we should be able to carry on mining operations without accidents, yet that many of them would be obviated by the combined efforts of science and practical knowledge.

BOSTON IRON MARKET—MONDAY, APRIL 20, 1857.

IRON.—Duty, 30 per cent. Steady; No. 1 Scotch pig at $35, and No. 1 American pig, at $34, per ton, 6 months.

Russia P. S. I Old Sable per ton of 2,240 lbs., 6 months	..	..	a	..	English foundry...none	..	..	a	..	..
do. New Sable	..	..	a	..	Scotch pig, 1st quality..	35	00	a	..	..
Swedish, ass'd com	95	00	a	100	do. other qualities ..	..	..	a	..	..
Square and extra sizes..	105	00	a	118	American pig. No. 1	33	00	a	35	00
Glendon Bar	..	..	a	..	Russia Sht, pl'd, per lb..	..	13	a	..	13½
Eng. round flat & square	..	..	a	..	English do	..	3½	a	..	4¼
Eng. round, refined	70	00	a	75	Penna. boiler, 1st qual..	..	5½	a	..	..
					do. 2d. do..	..	4½	a	..	..
					Brandywine do., best.	..	5	a	..	5¼

NEW YORK METAL MARKET—WEDNESDAY, APRIL 22, 1857.

Tin—Banca, 36¾c. to 37¼c., (cash;) Straits, 36c. to 36½c. (cash); Plates, I. C. 10-14 Charcoal, $11¼, (cash); Coke, $10¼ to $10⅜ (cash); Terne I. C. Charcoal, $11 to $11¼, 6 months; Terne I. C. Coke, 10⅜ to 10⅝, 6 months.

Zinc—8¾c. to 9c., 6 months.

Spelter—Silesian, 8 to 8¼, 6 months.

Lead—6¼ to 6⅝, cash.

Copper—Ingots, 28¼ to 28¾, 4 months; Chili Pig, 27½, 6 months.

Iron—Scotch Pig, $33 to $36, 6 months; Refined Bars., $70 to $75, 6

months; Com. English, $60 to $65; Sheets, Singles, 8¼ to 8½c., 6 months; Doubles, 4½c., 6 months.

Nails—Prime brands, 8¼ to 8½, cash.

Antimony—16 to 17c, cash.

PHILADELPHIA METAL MARKET—FRIDAY, APRIL 24, 1857.

Iron—	*From*	*To*	
Railroad Iron, per ton	$64 00	$65 00	cash.
Anthracite Pig Iron, No. 1, per ton		28 00	6 mos.
" " " 2, "	26 00	26 50	"
" " " 3, "	25 00	25 50	"
Scotch Pig		37 50	"
Charcoal Cold Blast	35 00	38 00	"
Bar Iron American	65 00	70 00	"
English Bar, common	62 50	65 00	"
" " refined	70 00	75 00	"
Swedish Bar	105 00	110 00	"
Fritzoe T. V. F. Bar	125 00		
Sheet, English, per pound	4	4¼	"
" Russian "	13	13½	"

Copper—	*per lb. 4 mos.*
Bolts & Brazier's sheets	$0 35
American Ingot	0 29
Lead—	*per lb.*
Drop shot	$0 07½
Mould Shot	0 06¾
Bar Lead	0 06¾
Pig Lead	0 06¾

Zinc—	*per lb.*
Sheet Zinc	$0 08½
Tin—	*cash.*
Banca Tin	$0 37½
Plates, I. C. Charcoal	0 11½
Terne	11

USES OF COAL TAR.

Coal Tar, as is well known, is the product left in gas works in the condensers, being formed from the coal with gas, and afterward deposited from the gas upon cooling. This substance was generally sold to the tar-distillers, who obtained from it a volatile fluid called coal naphtha, a light oil, composed principally of carbonic acid and a heavy oil of tar, a solid substance, called pitch, being also left in the retort. Coal tar has, of late years, been used in paving. When this substance, together with tar and asphalte, is heated, and poured while in a liquid state upon gravel, between the interstices of the paving stones, the whole is bound together so durably as not to require repaving for several years. When submitted to distillation in retorts, this pitch yields a porous, but at the same time a dense coke, and the oils distilled in the operation can be employed to advantage in lubricating machinery. Coal tar has also been applied, when mixed with gutta-percha or india-rubber, to insulate telegraph wires, and prevent metals from being acted upon by the atmosphere. One of the first products which comes over in the distillation of tar is a mixture of very volatile hydro-carbons, which has received the name of crude naphtha, and which, when distilled, is known as naphtha.

ON THE DRESSING OF ORES.

At a lecture recently delivered before the Government School of Mines, England, on this subject: the lecturer remarked that dressing was the sorting of the matrix from the metal or mineral, and was more or less employed in all mines. With regard to coal it was necessary to break from that the shale or iron-pyrites which was commonly left behind in the mine; that this was not always done effectually they knew perfectly well from the complaints of many housekeepers. In general all that was necessary in the dressing of coal was hand picking. The dresser was a sort of middleman; he had to receive the ore from the miner, and prepare it for the smelters. The amount of dressing was always to be determined on account of the quantity of ore to be got. Iron ores were generally found in large quantities and almost in a pure condition; if it were not so they would not be much worth working. The crystalline iron ores were nearly free from admixtures. Some specimens of brown iron,

interspersed through quartz, were then shown as unfit for dressing, on account of the cost of preparation. He next alluded to the dressing of lead, and several specimens were shown, in the one instance where the stone could be separated from the galena by a blow of the hammer, in others where it would be necessary that the whole should be bucked. Lead ore was generally required to be dressed to a very high pitch, as much as from 70 to 75 per cent. Copper ores were not obliged to be brought up to such a heavy percentage, the average produce of that being, in Cornwall, about 6 per cent. Tin being of a high price, the ores were required to be dressed to a greater state of purity. These ores were much disseminated throughout the stone, and the whole of the mass had often to be submitted to a process of reduction. With gold and silver greater care was taken, and this was invariably the case, as the metal being more precious, very small quantities would pay. In different countries the percentage differs; and in dressing operations much depends upon the management and cost of labor. With regard to iron ore, occasionally some of the smalls were jigged in England, but on the Continent, in several countries, especially Sweden, this metal was very carefully prepared for the furnace. Lead varies very much in the ore; if this be argentiferous, it will pay well when 1-2 a ton to the fathom is got. In South Wales sometimes as much as 24 tons of rough is picked over to extract 1 ton dressed. With regard to gold at St. John del Rey Mine, where the produce is 2 oitavas, or about 1-2 oz. per ton, the produce would make 25 oz. to 50 tons. At Kremnitz, they got 3 oz. to 50 tons: and at Salsberg and Tyrol 6 oz. to the same quantity. Although there are always some remains in the schlich, at Salsberg they go as low as 1 oz. to the 50 tons, though he did not mean to infer that this would pay. It was always a great advantage to select an eligible site for the dressing-floors; this should be on a gentle slope, so that the ore could be passed from one place to the other; this is sometimes not looked to; a spot as near the mine as convenient should be chosen. Before the ore was brought to surface, it should be saved as much as possible in the mine, as this would prevent re-picking, re-washing, and save haulage; and if thrown together, the dirt got mixed with the rich ore, and tended to deteriorate its quality; the dead should be left under-ground, in order to fill up the spaces. In Transylvania the tellurium and gold veins were generally left in a hulk, and afterwards taken out by particular individuals appointed for the purpose. The stones were in general brought from the mine in pieces large enough to be handled. In Mexico and Hungary, where the metal is in greenstone, clay adheres to the ore, and it is necessary that they should be carefully washed, broken, and picked. There were some minerals which should not be touched with water, especially where they were pulverulent, such as the oxides of copper. In Hungary the ore was often dressed by contract, and measured in a machine made for the purpose. In parts of Derbyshire and Flintshire gratings were used, and the ore picked from the one to the other. In the quicksilver mines of Idria, the gratings used were of different sizes; there would be one perhaps with bars of iron an inch apart, followed by another of 1-2 inch wide, and then with a third having fine wire interwoven. Dressing could be performed by old people, who were past labor, and young children; so that mines not only employed able-bodied laborers, but a great number of others, who probably, if it were not for this resource, would have to seek parish relief. The ores at the copper mines in the county of Wicklow were principally dressed by children. At Messrs. Taylors' mines in Cardiganshire, the ores are delivered by a quantity of water, and a cylindrical griddle is employed; a diagram of this was shown, as well as several others descriptive of the modes of dressing various minerals. Rittenger's conical barrel with the assistance of a raff-wheel, would wash 8 to 9 tons daily. Great improvements have lately taken place in Austria. In general the ores were first spalled, and afterwards bucked or cobbed according to circumstances; and, although they were generally crushed on a plate of cast-iron, it was still commonly called a knock-stone. In many of the old workings, in

Wales especially, stone hammers, much worn, were often found, and probably, in former times, these had been used to crush ore or stones; in some places large pestles and mortars were used, the latter of a size nearly as large as those used for warlike purposes. The model of a tilt-hammer, worked by a water-wheel, was then shown; but the lecturer observed it had not answered the expectation of the inventors, as the face of the hammer was so soon cut to pieces. In Cornwall, the ores were divided into three classes— prille, dredge and halvans, the deads being denominated attle. In Derbyshire they had four sorts—bing ore, dashed work, cuttings, and smithams; the peculiarities, of these were then described, and the lecturer concluded with some interesting remarks on their general properties.

NEW PUBLICATIONS.

"SCAMPAVIAS FROM GIBEL TAREK TO STAMBOUL." By Harry Gringo; (Lieut. Wise, U. S. Navy) author of "Los Gringos" and "Tales for the Marines." 12mo. pp. 362. New York, Charles Scribner, 377 & 379 Broadway. This volume is a record of a cruise in the Mediterranean, in the U. S. frigate Cumberland, and is written in that easy, gossiping style which, upon such a subject, is very attractive and agreeable. The title of "Scampavias" was taken from the name given to the clipper dispatch vessels used by the Knights of Malta in the olden times, and means, literally, Runaways. Its selection by the author is a good indication of the manner in which he has accomplished his work, which is filled with the most lively and graphic sketches of personal adventure in Gibraltar, Spezia, Naples, Athens, Constantinople, &c., together with descriptions of the scenery, customs and manners of that classic region. In short, it is a very pleasant companion.

"EXAMPLES FROM THE 18TH AND 19TH CENTURIES." By Mrs. L. H. Sigourney. A very handsome 16mo. volume of 350 pages; published by Charles Scribner, 377 & 379 Broadway. This work consists of sketches of the lives of seventeen of "the great and good" who were born in the 18th century; among whom we find the names of John Wesley, Lady Selina Huntington, Bishop White, Robert Hall, Hannah More, Mrs. Hemans, Mrs. Ware, Roger Sherman, and others equally distinguished in the world of Christian beneficence and religious literature. These sketches are written in the style and spirit characteristic of their accomplished authoress, and we cannot but echo her sentiment, and express the hope that "what we thus contemplate and admire, may become not only a ruling sympathy, but a pattern of life." We hope soon to welcome the second series, embracing the brightest names of the 19th century, and, in the mean time, commend this volume to the favor of all who have children to be influenced by the teaching of such examples.

THE

MINING MAGAZINE:

DEVOTED TO

Mines, Mining Operations, Metallurgy, &c., &c.

VOL. VIII.—JUNE, 1857.—No. VI.

ART. I. — THE IRON MANUFACTURE OF GREAT BRITAIN — THEORETICALLY AND PRACTICALLY CONSIDERED. By WM. TRURAN, C. E. No. 17.

(Continued from page 417, Vol. VIII.)

SECTION XX.—COST OF MANUFACTURING CRUDE AND BAR IRON.

EXTENT OF THE MANUFACTURE.

THE economical extraction of the raw materials and their conversion into crude and bar iron is a subject of paramount importance to the ironmaster, and to the maintenance of our supremacy as the largest iron manufacturers of the day. Under ordinary circumstances manual labor enters into the cost of the various minerals and manufactured products to the extent of 88 to 90 per cent. of the outlay, and the cost of producing is augmented and declines with every rise and fall in the labor market. The cost of producing crude iron in the newer districts will depend on the price of labor and facilities for supplying the requisite quantity; in the older districts it is principally dependent on the richness and facilities for obtaining a sufficiency of the raw materials.

The cost of producing bar iron in the several districts is subject to great irregularities independent of those arising from the prices of labor and raw materials, and apparently is caused in part by the qualities of the crude iron, but to a greater extent by the degree of perfection attained in the forge and mill operations. The variation is shown in the following statement of the selling prices of pig and bar iron in March, 1850.

		£	s.	d.
GLASGOW.	Pigs	2	3	6
	Bars	5	15	0
STAFFORDSHIRE.	Pigs at works	3	5	0
	Bars ditto	6	0	0
WALES.	Pigs at shipping port	2	15	0
	Bars ditto	5	0	0

Hence, estimating by the difference between the price of pig and bar iron, the cost of converting into the latter in the respective districts would be

	£	s.	d.
Scotland	3	11	6
Staffordshire	2	15	0
Wales	2	5	0

The conversion of Scotch pigs into bars is largely pursued in the Welsh district, and the bars so manufactured, after paying freight to and from Glasgow, undersell the produce of local manufactories of malleable iron.

The South Wales is the largest seat of the manufacture, and to a certain extent regulates the prices in the other districts. The cost of raising minerals and manufacturing iron at Merthyr Tydfil, is exemplified in the detailed statements which follow. The period selected is July, 1843, when, from a general depression in the trade, the rate of wages was extremely low, and the high degree of economy necessary to meet the prevailing low prices for all descriptions of crude and manufactured iron, resulted in their production at costs considerably below those of any antecedent or subsequent period.

Cost of raising coal per ton, reduced from the expenses attending a monthly extraction of 36,089 tons.

	s.	d.
Cutting	0	11.8
Deadwork	0	3.6
Extra deadwork	0	1.
Hanliers	0	2.2
Horses, underground	0	5.4
Hauling to yard	0	2.
Roadmen	0	0.8
Hitching and landing	0	0.8
Hauling rubbish	0	0.9
Overmen and weighers	0	0.5
Royalty	0	3.6
Stores	0	0.6
Timber and propwood	0	1.2
Castings and tram-plates	0	2.8
Bar iron	0	0.8
Coal, bricks and lime	0	0.3
Drainage	0	0.2
General charges, including agency and office expenses	0	0.5
Total per ton	8	2.5

Cost of raising iron ore per ton, reduced from the expenses attending a monthly extraction of 15,728 tons from pits and levels.

	s.	d.
Raising, miner	4	4.
Deadwork	0	7.4
Extra deadwork	0	2.1
Hauling underground	0	8.1
" aboveground	0	2.8
Cleaning and filling	0	2.1
Hitching and landing	0	5.
Carpenters and smiths	0	0.2

	s.	d.
Royalty	0	3.7
Roadmen	0	0.3
Bar iron	0	2.2
Castings and tram-plates	0	3.3
Bricks, lime, and coal	0	0.3
Pit and tram timber	0	1.6
Oil and stores	0	0.3
Overmen and weighers	0	0.6
Drainage	0	2.
General charges	0	2.1
Total per ton	8	0.1

Cost of quarrying and delivering limestone on furnace yard, from the expenses attending the extraction of 823 tons monthly.

	s.	d.
Quarrying	0	3.6
Hauling	0	2.4
Roads	0	0.3
Coal and bar iron	0	0.6
Royalty	0	1.4
General charges	0	0.2
Total per ton	0	8.5

Cost of manufacturing pig iron from a mixed burden, deducted from the expenses attending a monthly production of 5546 tons.

Calcining :—	s.	d.
Labor	0	2.2
Coal	0	4.
General charges	0	0.8
Smelting :—		
Coal	7	0.5
Limestone	0	8.3
Raw ore (local)	16	5.3
Purchased ores (hematite)	5	4.4
Cinders	0	0.8
Castings and bar iron	0	1.1
Bricks, clay, and lime	0	0.4
Timber, stores, &c.	0	1.9
Blast	1	7.8
General charges	0	10.1
Labor :—		
Overmen and weighers	0	0.8
Wheeling calcined ore	0	2.8
Breaking limestone	0	2.6
Filling furnaces	0	5.6
Keeping "	0	5.6
Filling cinders	0	3.
Firing hot blast	0	1.
Stocking pigs	0	1.3
Hauling cinders	0	2.3
" iron	0	0.4
Tipping cinders	0	0.8
Unloading coal	0	3.8
Miscellaneous labor	0	2.
Carpenters, Fitters and Smiths	0	1.1

	s.	d.
Masons	0	0.6
Horses, hauling cinders	0	5.2
" laboring	0	1.1
Total per ton	£1 16	3.6

The yield of materials in the production of this iron was as follows:

	cwts.	qrs.	lbs.
Coal	44	2	11
Raw ore (local)	40	3	27
Purchased ores (hematite)	5	1	6
Forge cinders	6	2	10
Refinery cinders	7	1	4
Limestone	19	3	11

Cost of manufacturing refined plate metal on a monthly production of 5438 tons:

	£.	s.	d.
Crude iron (forge)	1	18	4.6
Ditto (ballast)	0	1	0.9
Old castings	0	1	6.4
Cokes	0	0	10.4
New castings	0	0	5.2
Timber, stoves, bar iron, &c.	0	0	0.5
Bricks, clay, and lime	0	0	0.2
Blast	0	0	4.
Labor:—			
Refining	0	0	3.7
Breaking metal	0	0	1.8
Inspecting refiners	0	0	0.6
Hauling metal	0	0	1.3
" Cokes	0	0	1.
" Cinders	0	0	0.9
Filling cinders	0	0	0.2
Smiths, Fitters, &c.	0	0	0.9
Total per Ton	£2	4	1.8

The yield of materials in producing this metal was:

	cwts.	qrs.	lbs.
Crude iron	22	1	6
New castings	0	0	11
Coal	5	3	5

Cost of manufacturing puddle bars on a monthly production of 5876 tons.

	£.	s.	d.
Materials:—			
Refined métal	2	2	2.4
Pigs	0	3	7.
Crop ends	0	0	1.
Coal	0	2	0.8
Castings and bar iron	0	0	11.4
Timber and stores	0	0	0.3
Bricks and clay	0	0	4.1
Engines and Machinery	0	2	0.6
General charges	0	0	8.1

Labor:—	£.	d.	s.
Weighing and wheeling metal to Puddlers	0	0	1.3
Puddling	0	4	6.8
Shingling	0	0	3.4
Rolling	0	0	6.2
Shearing bars	0	0	1.4
Filling ditto	0	0	2.3
Weighing ditto	0	0	1.9
Wheeling ditto	0	0	1.4
Piling ditto on bank	0	0	0.6
Inspecting puddlers	0	0	1.9
Masons	0	0	1.2
Turners	0	0	0.5
Smiths	0	0	1.1
Unloading coal	0	0	1.
Filling cinders	0	0	1.2
Ditto ashes	0	0	1.9
Hauling ditto	0	0	0.3
Cleaning forge	0	0	0.3
Total per ton	£2	18	10.4

The yield of material in the production of the bars was:

	cwts.	*qrs.*	*lbs.*
Refined metal	19	0	12
Pigs	1	3	19
Mill crops	0	0	4
Furnace coal	15	1	20
Engine ditto	2	0	5
Clay	1	0	16
Bricks 6.9			

Cost of manufacturing rail and heavy bars of No. 2 iron, on a monthly production of 5150 tons:

	£.	s.	d.
Materials:—			
Puddle bars	3	5	5.4
Coal	0	2	8.8
Bricks and clay	0	0	1.
Engines and Machinery	0	2	0.7
General charges	0	0	11.3
Labor:—			
Wheeling iron	0	0	2.2
Filling	0	0	0.8
Hauling to Mills	0	0	0.7
Piling	0	0	1.4
Heating	0	1	2.8
Shingling	0	0	3.2
Roughing	0	0	7.4
Rolling	0	0	5.1
Carriage men	0	0	1.1
Hookers	0	0	0.6
Straighteners	0	0	4.5
Sawing	0	0	1.6
Filing	0	0	3.6
Weighing Bars	0	0	1.9
Inspecting and time keeper	0	0	2.5
Turners	0	0	3.8
Filling ashes	0	0	0.8

	£	s.	d.
Hauling	0	0	0.4
Tipping	0	0	0.2
Filling cinders	0	0	0.4
Cleaning mill	0	0	0.2
Masons	0	0	1.9
Smiths	0	0	0.8
Loading iron	0	0	1.4
Total per ton	3	16	4.5
Less, crop ends	0	3	2
Net cost	3	13	2¼

The yield of materials in the mill in the manufacturing being:

	cwts.	qrs.	lbs.
Puddle bars	22	1	27
Crop ends	..	..	..
Furnace coal	19	1	3
Engine coal	4	1	26
Clay	0	2	5
Bricks 6.8			

At the same period the cost of generating the blast per ton of pig iron made by blast furnace stood as follows:

	s.	d.
Coal	0	10.5
Castings and bar iron	0	1.2
Timber	0	0.1
Oil and other stores	0	2.
Brass and steel	0	0.2
General charges	0	0.9
Engineers	0	1.8
Stokers	0	1.2
Smiths and fitters	0	0.9
Inspecting and carpenters	0	1.
Total	1	7.8

And the expenses of maintaining the forge engines and machinery per ton of puddle bar and finished iron made, were:

	s.	d.
Coal	0	4.8
Castings and bar iron	0	7.3
Clay, bricks, and timber	0	0.2
Oil and other stores	0	4.3
Brass and steel	0	2.1
General charges	0	0.8
Engineers	0	1.9
Stokers	0	1.1
Carpenters	0	1.5
Smiths and fitters	0	0.5
Inspecting	0	0.2
Total	2	0.7

The cost of raising ores in Dean Forest, with rates of wages considerably higher than the foregoing amounted to 7s. 2¼d. viz:

	s.	d.
Raising	0	5.5
Deadwork	2	11.3
Hitching and landing	0	2.3
Engineers, &c.	0	2.5
Coal	0	5.3
Timber and sawing	0	4.
Filling and cleaning	0	2.3
Carpenters and smiths	0	2.6
Roads	0	1.4
Stones	0	1.3
Total per ton	7.	2.5

Pig iron may be produced in Scotland from the carbonaceous ores, at prices considerably under those prevailing in Wales. With similar depressing circumstances at the Langloan and adjacent works, the ton is manufactured at the following cost.

	£.	s.	d.
Calcinated ore, 33 cwts.	0	16	0
Raw coal, 38 cwts.	0	6	8
Limestone 5 "	0	1	1
Blast engine	0	0	8
Hot blast	0	1	2
Labor at furnaces	0	2	9
Stores, bricks, clay, &c.	0	0	2
General charges	0	0	10
Total cost per ton	£1	9	4

STATE OF THE MANUFACTURE, PIG IRON WORKS IN GREAT BRITAIN IN 1855.

Statement A.—List of Works, and Number and Capacity of Blast Furnaces in the South Wales District.

Name of Works.	No. of Furnaces.	Weekly Make per Furnace. Tons.	Annual Production of Furnaces. Tons.
Dowlais, and	14	116	84,448
Ifor	4	116	24,128
Nantyglo, and	8	120	49,920
Beaufort	7	120	43,680
Cyfarthfa, and	7	100	36,400
Ynisfach	4	100	20,800
Rhymney	9	125	58,500
Plymouth, and	5	100	26,000
Duffryn	4	120	24,960
Penydarran	7	100	36,400
Tredegar	8	110	45,760
Abersychan	6	160	55,920
Blaenafon	5	120	31,200
Varteg	5	120	31,200
Sirhowy	5	130	33,800
Oakwood	5	100	26,000
Coalbrook dale	5	100	26,000
Cwm avon	4	100	20,800
Hirwain	4	130	27,040
Clydach	4	90	18,720
Ebbw vale	4	130	27,040
Victoria	4	200	41,600
Llwynvi	4	90	18,720
Aberdare, and	3	125	19,500
Abernant	3	115	17,940
Aberamman	3	120	18,720
Cefn Cwse	3	90	14,040
Garth	3	95	14,820
Pentwyn	3	120	18,720

South Wales District. (Continued.)

Name of Works.	No. of Furnaces.	Weekly Make per Furnace. Tons.	Annual Production of Furnaces. Tons.
Pontypool	3	120	18,720
Blaina, and	3	150	23,400
Cwm Celyn	3	210	32,760
Gadleys	2	90	9,360
Pentyrch	2	100	10,400
Tondu	2	90	9,360
Golynos	2	120	12,480
Cwm brane	1	170	8,840
Cefn Crib	1	90	4,680
Anthracite District.			
Ystalyfera	11	80	45,760
Ynisedwyn	7	80	29,120
Abernant	3	80	12,480
Gwendraeth	3	80	12,480
Banwen	2	60	6,240
Onllwyn	2	60	6,240
Penallt	2	60	6,240
Brynamman	2	60	6,240
Trimsaran	2	60	6,240
Saundersfoot	2	60	6,240
Abercarne	1	50	2,600
Total	206	190	1,182,656

Statement B. List of Works, and Number and Capacity of Blast Furnaces in Dean Forest, North Wales, and Lancashire.

Name of Works.	No. of Furnaces.	Weekly Make per Furnace. Tons.	Annual Production of Furnaces. Tons.
Dean Forest.			
Cinderford	3	100	15,600
Sowdley	2	90	9,360
Shakemantle	2	100	10,400
Parkend	2	90	9,360
Bromley	1	80	4,160
North Wales.			
Coed Talon	5	50	13,200
Rhuabon	3	100	15,600
Llwyneanion	2	60	6,240
Brymbo	2	70	7,280
Frood	2	60	6,240
Pant	2	50	5,200
Plasisca	1	60	3,120
Pleskynaston	1	50	2,600
Plankey	1	50	2,600
Lancashire Charcoal.			
Blackbarrow	1		1,200
Newland	1		1,200
Duddon	1		1,200
Lorn	1		600
Total	33	67	115,480

Statement D. List of Works, and Number and Capacity of Blast Furnaces in the North Staffordshire District.

Name of Works.	No. of Furnaces.	Weekly Make per Furnace. Tons.	Annual Production of Furnaces. Tons.
Apedale	4	120	24,960
Kidd's Grove	3	110	17,160
Etruria	3	100	15,600
Lane End	3	100	15,600
Tunstall	2	85	8,880
Madeley	2	100	10,400
Silverdale	2	90	9,360
Total	19	104	102,960

Statement C. List of Works, and Number and Capacity of Blast Furnaces in the South Staffordshire District.

Name of Works.	No. of Furnaces.	Weekly Make per Furnace. Tons.	Annual Production of Furnaces. Tons.
Bilston, new	5	125	32,500
Stow Heath	5	110	28,600
Russell's Hall	5	120	31,200
Dudley's Wood	4	110	22,880
Tipton	4	110	22,880
Oldbury	4	110	22,880
Corbyn's Hall	4	110	22,880
Shut end	4	120	24,960
Parkfield	4	100	20,800
Birch Hills, new	4	110	22,880
Chillington	4	110	22,880
Bentley Heath	4	100	20,800
Darlaston Green	3	95	14,820
Moseley	3	120	18,720
Osier Bed	3	110	17,160
Priestfield	3	100	15,600
Millfield	3	120	18,720
Wolverhampton	3	100	15,600
Bilston	3	110	17,160
Priorfields	3	100	15,600
Caponfield	3	150	23,400
Wednesbur Oak	3	95	14,820
Willingsworth	3	100	15,600
Goldshill	3	110	17,160
Crookhay	3	110	17,160
Conoygree	3	120	18,720
Wednesbury Old Park	3	110	17,160
Union	3	110	17,160
Ketleys	3	95	14,820
Corbyn's Hall	3	120	18,720
Lays	3	110	17,160
Level	3	120	18,720
Corngreaves	2	110	11,440
Bumble Hole	2	100	10,400
Withymoor	2	100	10,400
Windmill end	2	100	10,400
Dixon's Green	2	110	11,440
Parkhead	2	100	10,400
Netherton	2	110	11,440
Woodside	2	130	13,520
Level	2	100	10,400
Brettel Lane	2	85	8,840
Oak Farm	2	110	11,440
Dudley Port	2	110	11,440
Parklane	2	100	10,400
Tipton	2	110	11,440
Tipton Green	2	110	11,440
Horseley	2	100	10,400
Ettingshall	2	110	11,440
Deepfield	2	100	10,400
Coseley	2	85	8,840
Bouvereux	2	110	11,440
Bilston Brook	2	80	9,320
New Darlaston	2	100	10,400
Birch Hills	2	90	9,360
Hatherton	2	100	10,400
Pelsall	2	100	10,400
Stonefield	1	110	5,720
Deepfield	1	100	5,200
Hallfield	1	100	5,200
Toll End	1	110	5,720
Corbyn's Hall	1	100	5,200
Old Hill	1	100	5,200
Darlaston	1	110	5,720
Stour Valley	1	100	5,200
Total	169	108	950,250

Statement E. List of Works, and Number and Capacity of Blast Furnaces in the Derbyshire District.

Name of Works.	No. of Furnaces.	Weekly Make per Furnace. Tons.	Annual Production of Furnaces. Tons.
Starcley	4	90	18,720
Codnor Park	3	110	17,160
Alfreton	3	90	14,040
Butterley Hall	3	100	15,600
Wingerworth	3	120	18,720
Staunton	3	120	18,720
Morley Park	2	70	7,280
Renishaw	2	110	11,440
Clay cross	2	100	10,400
Adelphi	2	100	10,400
West Hallam	2	100	10,400
New Bold	1	100	5,200
Total.....	30	101	158,080

Statement F. List of Works, and Number and Capacity of Blast Furnaces in the Shropshire District.

Name of Works.	No. of Furnaces.	Weekly Make per Furnace. Tons.	Annual Production of Furnaces. Tons.
Stirchley	4	90	18,720
Old Park	3	90	14,040
Horsehay	3	90	14,040
Donnington	3	80	12,480
Urmbridge	3	80	12,480
Ketley	3	80	12,480
Bedlam	3	80	12,480
Castle	2	90	9,360
Lightmoon	2	90	9,360
Snidshill	2	89	9,280
Lodge	2	89	9,280
Langley	2	89	9,280
Bleet Hill	1	80	4,160
Lawley	1	80	4,160
Total.....	34	86	151,720

Statement H. List of Works, and Number and Capacity of Blast Furnaces in the Northumberland District.

Name of Works.	No. of Furnaces.	Weekly Make per Furnace. Tons.	Annual Production of Furnaces. Tons.
Consett	7	130	47,320
Crookhall	7	130	47,320
Eston	6	140	43,680
Towlaw	6	140	43,680
Walker	5	150	39,000
Middlesbro'	4	140	29,120
Ormesby	4	120	24,960
Bradley	4	150	31,200
Witton Park	4	140	29,120
Middlesbro'	3	140	21,840
Eston	3	130	20,280
Clarence	3	140	21,840
Hareshaw	3	120	18,720
Birtley	3	110	17,160
Stockton	3	120	18,720
Darlington	2	120	12,480
Eston	2	110	11,440
Bedlington	2	120	12,480
Jennington	2	100	10,400
Tyne Main	2	120	12,480
Feiling	2	140	14,560
Wylam	1	140	7,280
Stanhope	1	120	6,240
Total	79	132	541,320

Statement G. List of Works, and Number and Capacity of Blast Furnaces in the Yorkshire District.

Name of Works.	No. of Furnaces.	Weekly Make per Furnace. Tons.	Annual Production of Furnaces. Tons.
Low Moor	6	70	21,840
Bowling	5	70	18,200
Bierly	4	80	16,640
Elsecar	3	60	9,360
Farnley	2	60	6,240
Thorncliffe	2	80	8,320
Chapel Town	2	65	6,760
Milton	2	80	8,320
Holmes	2	60	6,240
Worsbro'	1	70	3,640
Waterloo	1	70	3,640
Park Gate	1	140	7,280
Total	31	72	116,480

Statement I. List of Works, and Number and Capacity of Blast Furnaces in Scotland.

Name of Works.	No. of Furnaces.	Weekly Make per Furnace. Tons.	Annual Production of Furnaces. Tons.
Gartsherrie	16	150	124,800
Dundyvan	9	150	70,200
Glengarnock	9	150	70,200
Monkland	9	150	70,200
Calder	8	140	58,240
Clyde	7	130	47,320
Govan	6	150	46,800
Carnbroe	6	140	43,680
Summerlee	6	150	46,800
Coltness	6	150	46,800
Forth	6	150	46,800
Langloan	6	150	46,800
Blair	5	140	36,400
Carron	5	120	31,200
Omoa	4	150	31,200
Shotts	4	150	31,200
Muirkirk	4	140	29,120
Kinniel	4	140	29,120
Eglintoun	4	140	29,120
Lugar	4	140	29,120
Castlehill	3	140	21,840
Dalmellington	3	140	21,840
Nithsdale	3	120	18,720
Lochgelly	2	120	12,480
Portland	2	140	14,560
Garscube	2	150	15,600
Devon	2	120	12,480
Total	145	145	1,082,640

Statement K. Abstract of Number of Blast Furnaces in Great Britain in 1855; their Mean Weekly Produce, and Gross Annual Production when under Blast.

District.	No. of Furnaces.	Mean Weekly Produce of each Furnace.	Annual Production of Crude Iron. Tons.
South Wales	169	118	1,042,776
Ditto Anthracite	37	72	139,880
Dean Forest, North Wales, and Lancashire	33	67	115,460
South Staffordshire	169	108	948,520
North Staffordshire	19	104	102,960
Derbyshire	30	101	158,080
Shropshire	34	86	151,720
Yorkshire	31	72	116,480
Northumberland	79	132	541,320
Scotland	145	145	1,082,640
Total	746	113	4,399,836

Statement L. Abstract of Mean Number of Furnaces in Blast during 1854; their Average Weekly Produce, and Total Production of Crude Iron for the Year.

District.	No. of Furnaces in Blast.	Mean Weekly Produce of each Furnace.	Total Produce for the Year. Tons.
South Wales	155	118	968,350
Ditto Anthracite	21	72	78,936
Dean Forest, North Wales, and Lancashire	12	67	42,000
South Staffordshire	159	108	841,200
North Staffordshire	18	104	97,500
Derbyshire	24	101	126,456
Shropshire	25	86	111,580
Yorkshire	22	72	82,054
Northumberland	56	139	363,600
Scotland	116	145	964,640
Total	599	118	3,585,906

Statement M. Abstract of Quantities of Minerals consumed in the Manufacture of Crude and Malleable Iron during the Year 1854.

District.	Argillaceous Ores of the Coal Formations. Tons.	Carbonaceous Ores of the Coal Formations. Tons.	Hematites of the Carboniferous Limestone. Tons.	Siliceous ores of the Oolitic Formation. Tons.	Limestone Flux. Tons.	Coal. Tons.
South Wales	3,128,000	120,000	260,000	90,000	950,000	6,240,000
Dean Forest, North Wales, and Lancashire	36,000	.....	80,000	.....	90,000	218,000
S. Staffordshire	2,028,000	60,000	110,000	110,000	600,000	5,292,800
N. Staffordshire	252,000	35,000	10,000	.....	80,000	504,000
Derbyshire	360,000	.....	20,000	30,000	120,000	720,000
Shropshire	420,000	.....	10,000	.....	140,000	670,000
Yorkshire	400,000	.....	.....	.....	100,000	492,000
Northumberland	450,000	30,000	25,000	350,000	180,000	1,860,000
Scotland	300,000	3,600,000	40,000	.....	260,000	3,450,000
Total	7,366,000	3,845,000	555,000	580,000	2,450,000	20,146,000

Statement N. Number of Blast Furnaces; their average Weekly Make, and Produce of Crude Iron by the several Iron-making Districts in 1839, and the Increase per cent. thereon at Christmas, 1854.

	STATE OF THE MANUFACTURE IN 1839.—MUSHET.				INCREASE PER CENT. IN THE SUBSEQUENT 15 YEARS.			
District.	No of Furnaces.	No. in Blast.	Average weeklymake Tons.	Annual production. Tons.	In the number of furnaces.	In the number in blast.	In the average weekly make.	In the annual production.
South Wales	123	118	71	442,440	37	31	66	116
ditto, Anthracite	4	4	55	11,440	825	425	31	594
Dean Forest, North Wales, and Lancashire.	29	18	55	800 52,400	14	.....	21	.....
S. Staffordshire	126	106	63	346,213	34	41	71	143
N. Staffordshire	10	7	50	18,200	90	157	108	438
Derbyshire	16	14	47	34,372	87	71	115	270
Shropshire	34	29	55	80,940	.....	.....	56	36
Yorkshire	29	24	42	52,416	7	.....	71	57
Northumberland	5	5	50	13,000	1480	1020	164	2846
Scotland	54	54	70	196,560	168	115	107	338
Total	430	379	63	1,248,781	73	54	87	187

(Conclusion.)

ART. II.—ORGANIZATION OF THE SCHOOL OF MINES AT FREIBURG, SAXONY.

(Continued from page 348, Vol. VIII.)

STRANGERS and those who pursue their studies at their own expense are not required to undergo an examination in these branches.

The studies of those whose expenses are paid by the government, continue during four years. Others can abridge this time, especially when they already possess a knowledge of the branches to which it is partly devoted—that is, mathematics, physics, chemistry, or practical ideas relative to mining or the treatment of ores. This time can be reduced to three, or even two years, but very rarely to one year. Some of the particular studies extend through a year, and most of them through two years.

Those who pursue their studies at their own expense, pay the following annual fees for the annual course :—

	francs.
Arithmetic and Geometry from the beginning,	74 00
Descriptive Geometry,	74 00
Practical Mathematics,	74 00
Demonstration of Machines for Mines,	66 60
Analysis,	55 50
Mechanics, and the art of Constructing Machines,	92 50
Fixing the Boundaries and Measuring Mines, Theoretical,	44 80
" " " Practical,	
For one student,	37 00
For a company,	74 00
Theoretical Chemistry,	74 00
Practical Chemistry,	92 00
Analytical Chemistry,	111 00
Metallurgy,	74 00
Forges,	37 00
Docimey,	111 00
Assaying with the Blowpipe,	44 05
Mineralogy,	111 00
Mineralogical Exercises,	37 00
Physics, Part 1.	44 80
Physics, Part 2.	44 80
Geognosy,	92 50
Petrifactions Science of,	44 80
Science of Mineral Deposits,	37 00
Architecture of Mines, 1st Part,	74 00
Architecture of Mines, 2d Part,	74 00
Law of Mines,	55 50
Style of Constructing Mining Affairs,	55 50
Use of Books,	37 00

The fees for drawing and instruction in the French language are such as are agreed upon between teacher and pupil.

The course commences in every year on the first Monday of October, and terminates on the last Saturday of July following; there are two months of vacation devoted to travelling or practical operations in mining.

The cost to students who defray their own expenses is as follows:—

A charge of 18f. 50 for enrollment.
A contribution of 14f. 80 to the Treasurer of the Academy, payable at the time of enrollment.
Also 9f. 20 per year to the Treasurer for light to Lecture-rooms, &c.

The fees above-mentioned for the courses pursued.

The other expenses for board, &c., are inconsiderable at Freiburg.

The total expenses, not including clothing and articles of pleasure and luxury, but under a reasonable economy, may be estimated at 1,100 francs per year.

ART. III.—THE PRACTICAL MINER'S GUIDE. By J. BUDGE. No. 4.

(Continued from page 464.)

OPERATION.

			Base. fath. ft. in.			Perpendicular. fath. ft. in.
∠14° 45′	1	½	0 1 6.33134 12	1	½	0 5 9.6373 12
			3 0 3.97608			11 3 7·5276
			0 0 3.05522			0 0 11·6045
			3 0 0.92086			11 2 7·9231

	Base. fath. ft. in.	Perpendicular. fath. ft. in.
∠40° 15′ —	0 3 10·52093 9	0 4 6·95274 9
	5 4 10.68837	6 5 2·57466

Summary of Bases. fath. ft. in.	Summary of Perpendiculars. fath. ft. in.
3 0 0·92086	11 2 7·9231
5 4 10 68837	6 5 2·57466
8 4 11·60923	18 1 10·49776
6	6
A B 52 feet 11 in.	A C 109 feet 10 in.

EXAMPLE 5.

When a lode has changed or reversed its underlay from north to south, or east to west.

Rule.—Add all the perpendiculars together, as in the last problem, but subtract the bases, made by the reverse or contrary shafts, one from the other, the remainder will be the true length of the base.

PROBLEM.

A diagonal shaft was found to incline and measure as follows, viz.

A B	-	-	54 feet 18° 45′
B C	-	-	42 do. 12° 15′
C D	-	-	69 do. 25° 0′

throughout the above drafts, the declination or underlay bore northerly, but from that depth D it made an angle of 7° 30′ in a southerly direction, and this last draft D E measured 96 feet. It is required to know the perpendiculars and bases of all the foregoing sides respectively and collectively.

OPERATION.

Bases Northerly.	fath.	ft.	in.	Perpendiculars.	fath.	ft.	in.
18° 45′—0	1	11·14364			0	5	8·17897
			9				9
B a	2	5	4·29276	A a	8	3	1·61073
12° 15′—0	1	3·27680			0	5	10·36062
			7				7
C b	1	2	10·93760	B b	6	5	0·52434
25° 0′—0	2	6·42852			0	5	5·25416
			11				11
	4	3	10·71872		9	5	9·79376
	0	1	3·21426		0	2	8·62708
D c	4	5	1·92798	C c	10	2	6·42284

Base Southerly.	fath.	ft.	in.		fath.	ft.	in.
7° 30′—0	0	9·39789			0	5	11·38403
			8				8
	1	0	3·18312		7	5	7·07224
			2				2
	2	0	6.36624	D d	15	5	2.14448

SUMMARY.

Bases.	fath.	ft.	in.	Perpendiculars.	fath.	ft.	in.
	2	5	4·29276		8	3	1.61073
	1	2	10·93760		6	5	0·52434
	4	5	1·92798		10	2	6·42284
					15	5	2 14448
North	9	1	5·15834				
South	2	0	6·36624		41	3	10·70239
					6		
	7	0	10·79210				
	6			F E	249 ft.	10 in.	
F A	42 ft.	10 in.					

EXAMPLE 6.

When a shaft has been sunk in error,* or not exactly at right angles with the lode.

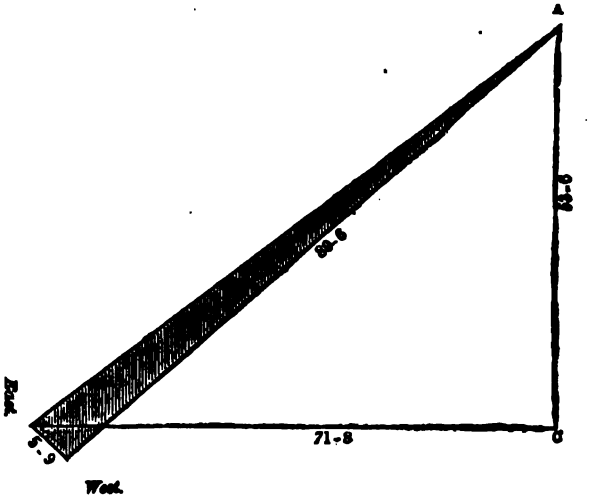
* Underlaying shafts are always intended to be sunk at right angles with the lode; that is, if the lode runs east and west, the horizontal bearing of the

Rule I.—Work for the base and perpendicular as before, by Case I., then find the deviation by the following

Rule II.—Take out the base from the second table, standing opposite the angle of error, and multiply it by the length of the shaft.

PROBLEM.

An oblique shaft A B was found to measure 89 feet 6 inches, on an angle of 53° 15′, and it was also observed that the shaft had declined 3° 45′ west from the intended right angle of the east and west lode: required the base C D and perpendicular C A, and how far the shaft has departed from its true course A D.



OPERATION.

			ft.	in.				ft.	in.
53° 15′	3	¼	4	9·69027	3	3	¼	3	7·07937
				7					7
			33	7·83189				25	1·55559
				2					2
			67	3·66378				50	3·11118
			2	4·24513				1	9·53968
	2	¼	1	7·23009		2	¼	1	2·35979
	0 6	¼	0	4·80752		0 6	¼	0	3·58994
	Base.		71	8·54652		Perp.		53	6·60059

shaft will be either north or south, as the lode may happen to underlie. But it is sometimes the case, that through inattention of workmen or other causes, the shaft has declined from its true course and inclined toward the right or left, and as this is neither a trivial nor uncommon occurrence, and admits not of development by the ordinary mode of dialling, we have here introduced a rule which will hold good in all cases of the kind.

THEN FOR THE DEVIATION.

		ft.	in.
Table 2d.— 3° 45′ Base	¼	0	4·7189
			7
		2	9·0323
			2
		5	6·0646
		0	2·3594
	⅛	0	0·78
	⅛	0	0·19
		5	9·3940

Thus it is clear that if the above shaft was sunk on an east d west lode and the angle of error inclined westerly, that the ot of the shaft B would be 5 feet, 9½ inches, in that direction yond its designed course A D.

EXAMPLE 7.

To find the perpendicular depth of the junction of lodes.

CASE I.

When two lodes underlay in the same direction.

Rule.—Subtract the tabular number of the base of the lesser ngle from the greater, then by direct proportion, say,

As this difference
Is to one fathom perpendicular,
So is the distance of the lodes at surface
To the junction of the lodes.

PROBLEM.

Two lodes were discovered at the surface, 12 fathoms apart from C to D, both underlying north. The southernmost lode D B made an angle of 38° 15′: the other C B 23°. Required the perpendicular depth A B where these lodes will unite, supposing they both regularly continue their respective angles of declination.

OPERATION.

	ft.	in.
From ∠ 38° 15′—4		8·7602
Take ∠ 23° 0′—3		6·5622
	2	2·1980

Then, As ft. 2 in. 2·198 : fath. 1 : : fath. 12

12 × 6 = 72

72 × 12 = 864·000

26·198 × 32 = 838·336

864·000 − 838·336 = 25·664

25·664 × 6 = 153·984

153·984 − 26·198 × 5 = 22·994

22·994 × 12 = 275·928

275·928 − 26·198 × 10 = 13·948

13·948 × 6 = 83·688

83·688 − 26·198 × 3 = 5·094

Answer, 32 fath. 5 ft. 4 in. A B

DIAGONAL LODES.

If it is required to find the respective lengths of the lodes C B and D B, and the horizontal line D A, work by Case II., where the perpendicular is given.

TO FIND D B.

∠38° 15′ | 1/9

	fath.	ft.	in.
	1	1	7·6831
			11
	14	0	0·5141
			3
	42	0	1·5423
	0	0	10·1870
D B	41	5	3·3553

Here we multiply by 33, and subtract from the product what the hypothenuse is minus of that measure, which being eight inches, is one-ninth of a fathom. This is the shortest method.

TO FIND C B AND D A, OR C A.

∠23° 0′ | 1/9

	Base. fath.	ft.	in.	Hypothenuse. fath.	ft.	in.
	0	2	6·5622	1	0	6·2179
			11			11
	4	4	0·1842	11	5	8·3969
			3			3
	14	0	0·5526	35	5	1·1907
	0	0	3·3964	0	0	8·6908
C A	13	5	9·1580	C B 35	4	4·4999

Then C A + C D = D A, or C A added to C D gives the line D A, 25 fathoms, 5 feet, 9 inches, &c.

EXAMPLE 8.

To find the perpendicular depth of the junction of lodes.

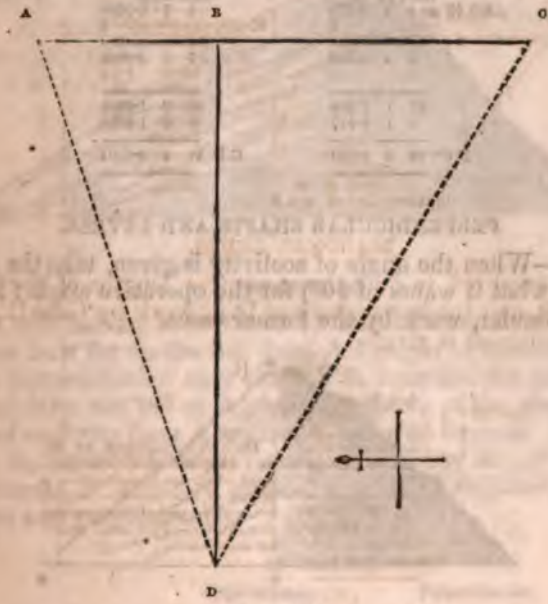
CASE II.

When two lodes, by their underlay, incline indirectly towards each other.

Rule.—Add the tabular bases together, then find the depth by direct proportion as in the last example.

PROBLEM.

Two lodes were observed 36 fathoms apart at the surface from A to C, the northernmost lode A underlaying south 18° 15′, and the southernmost lode C underlaying north 31° 45′ : required the depth B D at which these lodes will intersect each other.



OPERATION.

	ft.	in.	
To	∠18° 15′ = 1	11·622$_0$	
Add	∠31° 45′ = 3	8·555$_0$	
	5	8·177	

Then, As 5 8·177 : 1 : : 36

12 6

68·177 216

12

68·177) 2592·0000 (38·0

204531

546690

545416

12740

Answer 38 fathoms.

If required to find the length of the lodes A D and C the distance of the shaft B from the lodes C and A at the s work by case II. thus:

TO FIND A B AND A D.

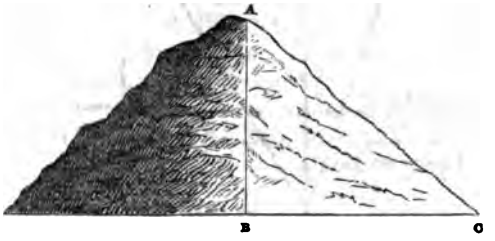
	Base. fath. ft. in.	Hypothenuse. fath. ft. in.
∠18° 15' =	0 1 11·622	1 0 3·6135
	6	6
	1 5 9·732	6 1 10·6810
	6	6
	11 4 10·392	37 5 5·2860
	0 3 11·244	2 0 7·6270
A B	12 2 9·636	A D 40 0 0·9130

TO FIND B C AND C D.

	Base. fath. ft. in.	Hypothenuse. fath. ft. in.
∠31° 45' =	0 3 8·555	1 1 0·7008
	6	6
	3 4 3·330	7 0 4·2048
	6	6
	22 1 7·980	42 2 1·2288
	1 1 8·110	2 2 1·4016
B C*	23 3 1·090	C D 44 4 2·6304

PERPENDICULAR SHAFTS AND LEVELS.

Rule.—When the angle of acclivity is given, take the c ment (or what it wants of 90°) for the operative angle; in other particular, work by the former cases.



EXAMPLE I.

A perpendicular shaft having been sunk from the t hill at A, from whence the slope to C measured 330 fee

* It may be observed that A B and B C added together do not fathoms, by something more than an inch: now this does not happen any defect in the tables, but because the perpendicular has not been out—for if the remainder (12740) was prosecuted, the perpendicula prove to be 88 fath. 0 ft. 1·3392 in., instead of 88 fathoms, which ad multipliers would make up the exact deficiency.

required to know the length an adit must be driven from the base of the hill at C to intersect the shaft at B, and what will be the depth of the shaft at that intersection, the angle of acclivity at C being 41 degrees.

BY CASE II.

	Perpendicular. ft.	in.	Base. ft.	in.
Comp. of 41° is 49°	3	11·23625	4	6·33909
		9		9
	35	5·12625	40	9·05181
		6		6
	212	6·75750	244	6·31086
	3	11·23625	4	6·33909
	216	5·99375	249	0·64995

EXAMPLE II.

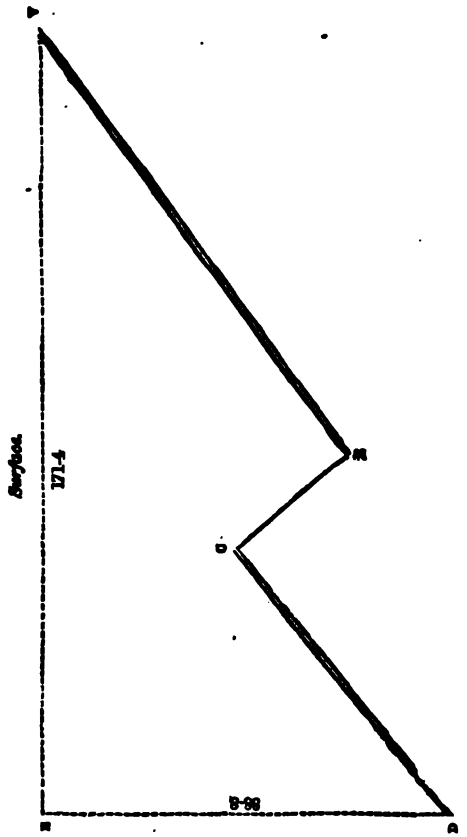
An adit having been driven 75 fathoms from A to B, required to know how far up the hill from A I ought to measure in order that a perpendicular may be sunk to intersect the adit at x, 58 fathoms from the tail at A; also the depth of the shaft C x, the angle of acclivity from A towards C being 33 degrees. Or thus:—Given the base 58 fathoms; angle of acclivity 33°, of which the complement or angle of declivity is 57°; required the hypothenuse and perpendicular.

BY CASE III.

	Hypothenuse. ft.	in.	Perpendicular. ft.	in.
Comp. ∠33° is 57° =	7	1·85016	3	10·75735
		8		8
	57	2·80128	31	2·05880
		7		7
	400	7·60896	218	2·41160
	14	3·70032	7	9·51470
A C	414	11·30928	C x 225	11·92630

EXAMPLE.

A shaft having been sunk on a lode 114 feet from A to B, on an angle of 54° 30′, at this place the lode was separated and thrown up by a slide, from B to C, 82 feet, the angle of elevation at B being 47°: at C the lode was again cut and prosecuted on an angle of 51°, from C to D, 73 feet. Required to know the length from A to E at surface, where a perpendicular shaft should be put down, that would intercept the lode at the foot of the diagonal C D; also the depth of the shaft E D.



THE FOREGOING EXAMPLE BY THE TABLES.

	Base. ft.	in.	Perpendicular. ft.	in.	
∠A 54° 30′ =	4	10·61632	3	5·61062	
		6		6	
	29	3·69792	20	10·86372	(Multiplier 19 fathoms.)
		3		3	
	87	11·09376	62	8·59116	
	4	10·61632	3	5·61062	
	92	9·71008	6	2·40178	

	Base.		Perpendicular.	
	ft.	in.	ft.	in.
∠B 47° 0′ / Comp. 43° 0′ =				
1/4	4	1·10388	4	4·65747
		5		5
	20	5·51940	21	11·28735
	1	4·36796	1	5·552 (Multiplier 5 fa. 2 ft.)
	21	9·88736	23	4·83935
∠C 51° 0′				
1/6	4	7·95451	3	9·31107
		12		12
	55	11·45412	45	3·73284 (Multiplier 12 fa. 1 ft.)
	0	9·32575	0	7·55184
	56	8·77987	45	11·28468

SUMMARY.

Bases.		Perpendiculars.	
ft	in.	ft.	in.
92	9·71008	∠A= 66	2·40178
21	9·88736	∠C= 45	11·28468
56	8·77987	112	1·68646
Answer E A = 171	4·37731	∠B= 23	4·83935
		D E= 88	8·84711

NOTE.—Perpendiculars to strike B or C and their respective horizontal distances from A are shown by the sums of the first and second operation in the above calculations.

When a lode has been thrown down by a slide.

Rule.—Add the perpendiculars together for the depth, and subtract the base of the slide from the bases of the segment of the lode for the horizontal.

EXAMPLE.

A shaft A B having been sunk 77 feet on a lode which made an angle of 34° 45′, it was there found that a slide had severed or disjoined the lode and carried it downward from B to C 40 feet, on an angle of depression or declivity 59°. Here (at C) the lode was again discovered, and wrought 102 feet from C to D, on an angle of 42° 15′; required the depth of the vertical line D E, and the length of the horizontal A E.

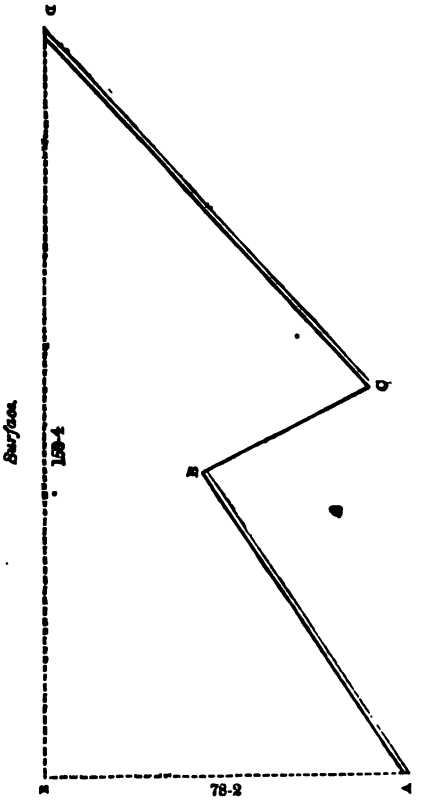
NOTE.—Should it be required to find the proper depth in the shaft D E from whence to drive a cross-cut to strike the end of the shaft A B, (where the slide first appeared)—the perpendicular of the first draft gives the depth, and the length of the cross-cut will be found by subtracting the base of the first draft from the horizontal line A E: and should it be necessary to make a drift from the shaft D E to the angle C, (where the lode was again discovered) the depth will be found by adding the perpendiculars of A and B together, and the bases of B and C will be the length of the drift.

THE FOREGOING EXAMPLE BY THE TABLES.

	Base.		Perpendicular.	
	ft.	in.	ft.	in.
∠A 34° 45′				
1/4	3	5·03977	4	11·15858
		12		12
	41	0·47724	59	1·90296
	1	8·51988	2	5·57929
1/4	1	1·67992	1	7·71952
	43	10·67704	63	3·20177

∠B 59° 0′		ft.	in.
	½	5	1·71995
			6
		30	10·29630
	½	2	6 85·02
		0	10·2·600
		34	3·44032

		ft.	in.
	½	3	1·08274
			6
		18	6 49644
	½	1	6·54137
		0	6 18045
		20	7·21826



∠C 42° 15′	Base. ft.	in.	Perpendicular. ft.	in.
	4	0·41041	4	5·2957
		4		4
	16	1 64164	17	9·1828
		4		4
	64	6 56656	71	0 7312
	4	0·41041	4	5·2957
	68	6·97697	75	0·0269

SUMMARY.

	Bases.	Perpendiculars.
	ft. in.	ft. in.
∠A . .	43 10·67704	63 3·20177
∠C . .	68 6·97697	20 7·21826
	112 5·65401	75 6·0269
∠B . .	34 3·44032	
Ans. A E =	78 2·21369	D E = 159[illegible]4·44693

HORIZONTAL DIALLING.

Rule.—Observe which side of the triangle is given, and work by the specified case.

When there is more than one draft in the operation, add the sums of the respective sides together for the answer.

EXAMPLE I.

Being required to put down a shaft 618 feet due east of an engine shaft at A, I am prevented from measuring in a direct line by intervening hills and wood: I therefore find it necessary, in order to avoid these obstructions, to go on an angle of 27° south of east from the shaft A. What distance must I proceed in this direction before I come at right angles with, or due south of, the eastern extremity of the given line, and how far must I then measure in a northerly direction to come exactly on the required spot. Or the question may stand thus:—Given the perpendicular 618 feet, angle 27°; the hypothenuse and base are required.

OPERATION.

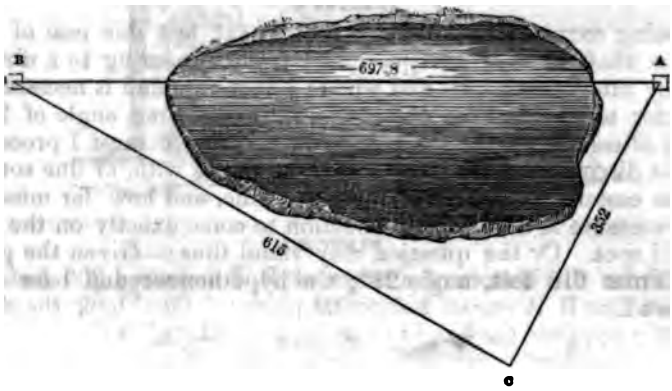
	Base.	Hypothenuse.
	ft. in.	ft. in.
27c =	3 0·6858	6 8·8075
	10	10
	30 6·8580	67 4·0750
	10	10
(Multiplier 103 fath.)	305 8·5800	673 4·7500
	9 2·0574	20 2·4225
	314 10·6374	693 7·1725

EXAMPLE II.

It being required to find the distance between two shafts A and B, which are inaccessible to a direct measurement on account of a marsh or lake lying in the way: I consequently measure 352 feet on an angle of 63° south of west, from A to C; at this station (C) I can see the shaft B, which I find by observation bears 29° north of west, and the line from C to B measures 615 feet; how far are these shafts apart in a right line? Or the question may stand simply thus:—

{ Given angle 63°, hypothenuse 352 feet. }
{ Given angle 29°, hypothenuse 615 feet. }

The sum of the perpendiculars* are required.



OPERATION.

∠A 63°		Perpendicular. ft.	in.	∠C 29°		Perpendicular. ft.	in.
(Multiplier 58 fa. 4 ft.)	½	2	8·68782	(Multiplier 102 fa. 3 ft.)	½	5	2·97262
			11				10
		29	11·56052			52	5·72620
			5				10
		149	9·80260			524	9·26200
		8	2·06196			10	5·94524
		1	4·34366			2	7·48631
	½	0	5·44788				
		159	9·65610			537	10·69355

SUM.

	ft.	in.
	159	9·65610
	537	10·69355
Ans. A B.	697	8·34965

* As in this instance the perpendicular only is wanted, there is no necessity for taking out the other side.

VERTICAL DIALLING; OR THE MENSURATION OF HEIGHTS.

Rule.—Observe the given side and angle, and work by the respective cases as heretofore.

EXAMPLE I.

From the bottom of a tower at B, I measured 200 feet in a direct line B A on an horizontal plane; I then took the angle A42°: required the height of the tower and staff B C.

OPERATION.

		ft.	in.
Complement of ∠A 42° is ∠C 48°	÷	5	4·82909
			11
		59	5·11999
			3
(Multiplier 53 fath. 2 ft.)		178	3·35997
		1	9·60969
Ans. B C		180	0·96966

In operations of this nature the hypothenuse need not be regarded.

EXAMPLE II.

Wanting to ascertain the height of an irregular hill, I proceed, from the several stations A, B, and C, to take the angles and measure the distances as follows, viz.:

From A to B ∠41° 0′ length 210 feet.
From B to C ∠22° 0′ length 216 feet.
From C to D ∠37° 30′ length 247 feet.

required the altitude E D.

OPERATION.

	Perpendicular. ft. in.
∠A 41° 0′ Comp. 49° 0′	3 11 23625
	7
6) 210	27 6·65375
35 Multiplier	5
	137 9·26875
∠B 22° 0′ Comp. 68° 0′	2 2·97167
	6
6) 216	13 5·83002
36 Multiplier	6
	80 10·98012
∠C 37° 30′ Comp. 52° 30′ | $\frac{1}{6}$ |	3 7·83082
	10
6) 247	36 6·30820
41 . 1 Multiplier	4
	146 1·23280
	3 7·83082
	0 7·30513
	150 4·36875

	ft.	in.
A	137	9·26875
B	80	10·98012
C	150	4·36875
Ans. height E D	369	0·61762

MISCELLANEOUS EXAMPLES IN THE FOREGOING RULES.

Given the hypothenuse 14 feet 5 inches, angle 83°: required the base and perpendicular.*

* In single drafts, one or two figures of the decimal will be sufficient, the others may be rejected.

		ft.	in.
Answer	Base =	14	4·69
	Perp. =	0	6·03

Given the perpendicular 100 feet, angle 60°: required the hypothenuse and base.

		ft.	in.
Answer	Hyp.=	200	
	Base =	173	2·428

Given the base 118 feet, angle (Comp.) 23°: required the hypothenuse and perpendicular.

		ft.	in.
Answer	Hyp =	301	11·97
	Perp.=	278	0·02

Given the angle 53°: required the underlay in a fathom.*

	fath.	ft.	in.
Answer	1	1	11·5472

Given the angle 36° 45′: required the underlay in a fathom.

	ft.	in.
Answer	4	5·5650

Given the angle 4° 15′; required the underlay in a fathom.

	in.
Answer	5·3496

A diagonal shaft having been sunk 8° 30′ out of its true course; what will be the extent of departure, supposing the length of the shaft 76 feet.

	ft.	in.
Answer	11	4·2577

Suppose a diagonal shaft was sunk as follows, viz:

∠87°	0′ =	14 5
∠47	0 =	11 2
∠87	30 =	36 3
∠69	30 =	26 2
∠77	30 =	23 2
∠65	30 =	9 2

Required the sum of the bases and perpendiculars.

Answer	Perp.	52	8·45944
	Bases	169	6·90784

Wanting to know the distance between two shafts, inaccessible in a right line, I measured from the first shaft 126 feet, on an angle of 27° 15′ E. by N.; from this station to the second shaft the line measured 91 feet, on an angle of 42° 30′ N. by W.: how far are the shafts apart?

	ft.	in.
Answer	179	1·3

Wanting to know the altitude of a precipice, I measured off from its base 66 feet, and from thence I take the angle to the summit, which I find to be 42°, (and consequently the complement 48°): required the height.

	ft.	in.
Answer	59	5·91999

* It has been before observed, that the underlay is given in the base of the second table.

At the foot of a hill the angle to the summit was 36°, from this place an adit had been driven in a direct line 218 feet: how far must I measure up the hill to put down a perpendicular shaft on the end of the adit, and what will be the depth of the shaft?

Answer { Hyp. or slope 261 5·54604
Perp. or shaft 153 4·09816

At the foot of a diagonal shaft, 28 fathoms in length, sunk on a lode 27° 45′ underlaying north, another lode was cut making an angle 48° 45′ underlaying south: what is the distance from the brace of the shaft to the back of the north lode?

FIRST TABLE.

	Base. ft.	in.	Perpendicular. ft.	in.
∠27° 45′	2	9·3	5	3·7
		7		7
	19	6 5	37	1·9
		4		4
	78	2·0	148	7·6

Divide this by 6 for the multiplier of the 2d angle,
fath. ft. in.
which will be 24 4 7·6

THEN—SECOND TABLE.

		Base. ft.	in.
∠48° 45′ Comp. 41° 15′	½	5	3·14
			6
		31	6·84
			4
		126	3·36
	½	2	7·57
	¼	0	10·59
	⅛	0	5.26
		0	0·65
		130	3·36

ANSWER.

	ft.	in.
Base of north lode	78	2
Base of south lode	130	3
Required distance	208	5

A perpendicular shaft having been sunk 168 feet in the side of a mountain, the slope or declivity making an angle with the shaft of 54° 15′: required to know how far I must measure down the hill to get at the right spot for driving an adit to come in the exact depth of the shaft,—the length of the adit is also required.

		ft.	in.
Answer	Slope	267	8·58
	Adit	233	4·40

A lode underlaying south was observed to make an angle of 17° 15′: required to know what distance from the back of the lode will be proper for sinking a perpendicular shaft that shall intersect the lode at the depth of 45 fathoms.

ft. in.
Answer 83 10·020

ART. IV.—ON THE MANIPULATION OF THE ORES OF GOLD, SILVER, COPPER, LEAD, NICKEL, AND OF DEVON AND CORNWALL, TO RENDER THEM MARKETABLE.—By GEORGE HENWOOD, M. E.

IN most cases the metalliferous parts from the lodes appear to the uninitiated an incomprehensible mass of rubbish, the ores being mostly concealed in the extraneous matter, such as flookan, or soft clay, if a flookan exist in the lode or in the earthy and slaty matter, forming the country in which the lodes are embedded. To the methods of separating them from this extraneous matter, the principal part of my paper will be devoted.

In some few veins the lodes are so rich in metal that nothing more is required than after their being raised to the surface, to *spall, i. e.*, to break off the refuse, and then (*buck*) bruise the ore down so that it may pass through a wire sieve, from the size of coarse sand up to that of a bean. This is practised at the Devon Consols, where the whole lode is crushed by machinery, and at once is ready for the market. Under this slight preparation, ores that contain only a small percentage of metal, may be profitably dressed. The principle adopted for the separation is the same in all cases, namely, their specific gravity—the near approach in weight of some varieties of the ores of different metals to each other existing in the same lode, renders this a matter of great difficulty. The medium or vehicle for this separation is usually water.

Some varieties of copper, particularly the black oxide of that metal is so light in its nature, that the lode stuff containing it cannot be subjected to water at all, as it would instantly wash away; the miners are therefore obliged to be very particular in breaking down the lode not to mix any refuse with it, as it would injure the sample and militate against his interests. I think I had better divide the methods of separation into a distinct description of each, beginning with gold.

The qualities of gold hitherto discovered have been so limited, that this metal has never been looked on until lately as a source of emolument to mine proprietors, the discoveries having been confined entirely to small nuggets and particles occasionally discovered in tin streams. During the last two years most marvellous statements of the produce of gold in gozzans have appeared, throwing into the shade the gold ores of South America, and other auriferous localities. These results were said to have been brought about by amalgamating and crushing machines, almost every week producing an improvement on the last "improved patent." The most popular machine, however, seems to have been that brought forward by an American gentleman, called Berdan. It consisted of two large cast iron basins, about eight feet in diameter, revolving at an angle of thirty degrees

from the horizontal line, and containing two cast iron balls, one of the weight of a ton, and the other about half that size; the larger ball ran first; the small ball, by continually pressing on the larger, made it not only revolve in the basin, but also made it revolve on its own axis, thus giving it a twisting as well as a rolling action. Into these basins were placed a quantity of quicksilver, whose rapid affinity for gold is well known, particularly when gently heated; to effect this, a charcoal fire was placed under the basin, the ore containing the gold was then placed in the basins, and when set in motion the balls would soon reduce it to powder; to prevent this, and to wash off the earthy matter, a jet of water was introduced, which escaped through gratings fixed for the purpose, something in the manner that will presently be described in tin stamping. As soon as the whole of the ore was reduced, the operators took out the quicksilver, with which the gold, if there be any, amalgamates, and after carefully washing it from any earthy matter, squeezed it through a skin of wash leather into an iron basin, the amalgam, if any, remaining in the leather; this amalgam is then subjected to a moderate heat in a crucible, to volatalize the mercury, when by being smelted with the addition of a little borax, the gold is produced in most instances alloyed to some extent with silver, copper, and nickel.

Mr. John Calvert, of London, now propounds a method of procuring gold from the ore by Voltaic electricity. He says, by his method he decomposes the ore and collects the metal. As his method has not yet been promulgated, it would be premature to offer any remarks, except that I wish he may succeed.

The enormous produce of 17 oz. to the ton, was said to have been procured by this process; by chemical assay he stated the yield to be, in one experiment, 9 oz., and a second 11 oz. per ton. All these three results were obtained from the same sample.

I tried some of the same gozzan from which such glowing returns had been declared, by carefully grinding the ore and amalgamating it with mercury. Here I had every advantage and opportunity, and though I operated on no less than half a ton of the supposed auriferous ore, not a vestige could I obtain in either case.

In the production of silver, the miner is much more fortunate, this mineral not only being far more abundant, but is much more easily reduced from the ore.

I have previously mentioned some mines producing silver in small quantities, of extraordinary richness: I have seen specimens from Illogan parish that will yield more than 2,000 oz. to the ton; but the greatest quantities are obtained from the gozzans and lead ores, the latter average in Cornwall about 35 oz., in Devon 40 oz. per ton. The gozzans vary considerably, and sell at from forty shillings to forty pounds per ton. After rais-

ing they are merely bruised to a small size, and sent off to the smelting works, no further treatment being requisite. To reduce the silver from these ores, it is necessary to mix them with certain portions of lead ore of low average for silver; the two are then melted together, and run out into pigs or blocks, these are then gradually melted in a crucible, called a test, made of bone dust and clay beaten into a hard body; the liquid metal as it runs into the test, is subjected to a tremendous heat from a reverbatory furnace, by which it becomes oxidized and converted into litharge, in which state it is foliated; a blast of cold air is then introduced, which blows off the litharge from the side of the test, and it falls into a receptacle below; the litharge is easily melted into pig lead by a subsequent process.

As soon as the cold blast, which is almost instantaneous, ceases, foliation again takes place; this alternation of heat and cold is continued until all the lead has been blown off, the silver not being acted on by the heat except being fused, remains, and after a little refining is rendered fit for sale.

As may be supposed, a considerable waste of lead takes place by volatilization; no silver ores containing less than 12 oz. of pure silver to the ton are worth the cost of refining, indeed silver lead (Galena) containing less than 4 oz. of silver per ton, are seldom found to pay the expense and trouble of extraction.

Many of the flookan lodes of vast size contain from four to eight ounces per ton, and could a cheap process of reduction be resorted to, the supply of this beautiful and valuable metal might be wonderfully increased; many attempts have been made to concentrate the silver ore, by washing and constructing slime pits, to get rid of the earthy matter and retain the valuable portion, but so light is this metal in some conditions of the ore, that like oxide of iron and some varieties of copper ore, it floats away, I have never seen it adopted with success. I have no doubt it may be precipitated by some agent, and here is a field of discovery open, and a profitable one too, for many of these flookans are known to hold the metal, having been proved by assay to contain it to the amount of several ounces in the ton. I have heard the late Captain of East Wheal Rose (John Champion) regret the consciousness of hundreds of tons of silver ore having run down the rivulet, passing through that mine, which was too subtle for them to collect and render remunerative.

The method of "dressing," *i.e.*, rendering copper ores fit for market, is our next subject; and here so many methods are adopted, which are also used for tin and lead, that I must make one desciption of each of these processes serve. Stamping, for instance, which properly belongs to tin, and with the tin dressing I shall describe it.

Copper ore is generally mixed with mundic (sulphuret of iron) in large quantities, with spars of various kinds, and other

foreign matters. These are broken (spalled) off, and the copper carefully selected; this process of spalling reduces the blocks to the size of oranges; on extensive mines these are then passed between iron rollers, and sifted to select all such pieces as are larger than a bean; these are recrushed to that size. On mines of smaller produce, these larger pieces are broken down by women or boys striking them with a hammer on a piece of iron like a small anvil, which they do with amazing rapidity; during this process they reject any extraneous substances that may have escaped the notice of the spaller. This operation is termed "cobbing," and is applied to the best quality of ore. It is again subjected to "bucking," that is, bruising down the size of a bean as before described, when it is put "to pile" or heap for sampling and weighing, the last duty of the miner.

During the spalling many pieces containing copper in small quantities are thrown on one side as "dredge work;" this dredge has to be ground very small and then "jigged," that is, placed in a wire-bottomed sieve, put into a trough of water and agitated by a peculiar tremulous perpendicular motion; this causes all the ore and refuse in the sieve to move gently, the heavier particles of course work their way to the bottom, being greatly assisted by the water medium lessening the specific gravity of the lighter foreign substances; the top stratum is then removed and the ore saved. This apparent refuse is again reduced still smaller, and then washed in a "strake," that is, an inclined trough about twelve or fourteen feet long, and twenty inches wide, down which a brisk stream of water is allowed to run, the heavier part of course remains nearer the stream than the earthy and stony: they are thus divided, this is then put to pile as a sample of inferior quality; "the "tailings" or best of the refuse from this operation is sometimes stamped and dressed in "sweep buddles" like tin, and this is the last manipulation copper undergoes on the mine. Native copper, which is sometimes discovered, requires no dressing; the gray and black oxides need very careful handling, and has always to be carried on by a dry process, water carrying off the richest parts of them.

The water flowing from some of the mines is so highly charged with copper that it pays to precipitate it; this is usually done by running the water into ponds until it is nearly clear, when tin-plate clippings, iron borings, and scrap iron ore are introduced, these soon collect all the copper, which is then easily preserved; the copper thus procured is very rich in quality. This process is extensively carried out at the Paris Mountain Mine, Anglesea, Wales.

A natural instance of a somewhat similar nature occurs at Perran Zabuloe, on the north coast of Cornwall, where the water from the adit of a mine that has been abandoned some years, percolates the sand on the sea beach, the carbonate of lime co-

tained in this sand (composed chiefly of comminuted shells and saturated with sea water) arrests the copper in solution, and forms it into a carbonate of copper worth about six pounds per ton.

Some thousands of pounds worth were secured in this way.

So hard had this floor of copper, varying from one to eight inches thick, become cemented together, that it was found necessary to use powder to remove it; in doing so many singularly grotesque nodules and masses were discovered formed round large shells and pieces of drift wood, these were much sought after as cabinet specimens. I was fortunate enough to procure some of very fine form. This natural copper ore *manufactory* is still in operation, and must afford a good profit to the lord of the manor on which it is situated.

There is little doubt these methods might be made available in many of of our rich mines, whose waters are now pumped away without consideration, and seem to give a broad hint that the silver may also be secured by some similar agency.

I have now described all the treatment copper receives previous to sampling, which ceremony I shall describe in the sequel.

Nickel is dressed in precisely the same manner as copper, except being so valuable, the greatest possible care is taken in selecting it. It sells at about £40 to £60 per ton when good. Blende, the ore of zinc, is also treated in a manner so similar as to render any separate description unnecessary.

This ore, until the last five years would not pay for raising, and even now no ore displays so great a discrepancy in value, as exists between this in its crude state and metallic zinc, the former selling at only £2 10s. to £3 per ton, whilst spelter sells at £22 to £25. It is to be hoped for the miners' sake this state of things will be improved. Tin ore requires the most delicate and tedious process, and is by far the most difficult metal to extract from the stones and minerals with which it is associated.

Lead next claims our attention, but this will require little description, the dressing of this ore partaking of both the methods of tin and copper. When the ore is very rich and pure it is carefully cobbed, and then crushed between iron rollers to the requisite size. These crushing machines are great auxiliaries to dressing operations; when complete, they draw up an inclined plane a railway wagon laden with about two tons of the cobbed mineral, whilst an empty one descends: the ore is tipped by the machine into a hopper which feeds the rollers regularly; after passing between them, the ore falls into a cylindrical wire sieve fixed on a bevil, the parts not crushed sufficiently small are thus thrown out of the sieve, and are conveyed to the hopper above by a large wheel having buckets on the side of the rim to receive it; when the ore revolves to the upper part, the buckets discharge it on an inclined plane, where it re-enters the hopper with the coarse ore. Those parts of the ore mixed with impuri-

ties, are subjected to a stream of water to wash off the fluean clay, &c., and then crushed down to undergo the strake process in the same manner as copper, &c.

In many cases, especially where the lead is mixed with blende or white iron, the separation is difficult, and recourse is had to stamps on the same plan as tin; the sweep buddle before described is then brought into requisition with excellent effect. Lead ores in Cornwall and Devon, when ready for sale, fetch about £12 to £30 per ton, this great range depending upon the quantity of silver contained in it.

Antimony is raised and dressed in small quantities, and is treated in the same manner as lead: it fetches about £10 per ton.

Manganese requires to be selected from iron and sulphur as carefully as possible, it is then ground fine to be shipped off in casks. So little has been done in this mineral of late years, that its process of dressing is little known, and no price quoted. Cobalt is not now dressed in these counties.

Arsenic is largely prepared from deposits in the flues of tin and lead roasting and smelting houses; this crude arsenic is periodically collected and sold; this matter is then subjected to sublimation and cupellation ere it becomes fit for sale. When taken from the cupola, it has much the appearance of opal, and is sometimes beautifully marked by concentric layers as they were deposited. It now requires to be ground to an impalpable powder, and placed in casks for the market; its price is about £7 per ton. The manipulation of this mineral is a highly dangerous operation, the men employed seldom live many years, although every precaution is taken to prevent their inhaling any of the noxious mineral; if they have the smallest scratch or blain, the arsenic is sure to attack the part, and healing becomes a very tardy process. It is said cholera, small pox, and many other epidemic diseases, never approach the neighborhood of an arsenic mill. This immunity may be justly ascribed to the isolated and healthy situation of the works, which are always at a distance from habitations, and shunned almost as much as a powder mill.

Sulphuric pyrites have within the last two or three years been shipped for commercial purposes, but the demand has again fallen off. The only preparation required was a careful selection from impurities; it fetched £1 to £1 5s. per ton. Iron also is shipped in large parcels, and unless this ore exist in great quantities, and of good quality, it will not pay the cost of working. In prosecuting an iron mine, especial care should be had to its distance from the market or shipping port. Like sulphur it requires no dressing beyond a careful selection, and sells at from 12s. to 16s. per ton.

These are all the metals of commercial value produced in these

counties: there are mineral productions to an immense amount, in the shape of china and pipe clays, granite, porphyries, serpentine, ochre, limestone, &c., but as these do not come under my category of metallic ores, I shall pass them over.

SAMPLING DAY

is a day of considerable bustle and importance on mines; all the piles of ore are turned over twice so as thoroughly to mix them; they are usually in parcels varying from 10 to 120 tons. These piles are then divided into six equal lots, called "doles." The "*samplers*," the agents of the Copper Smelting Companies, then select two doles from each parcel, from which they take a small bag full of ore as a fair sample, to make their assay as a guide to their price when tendering for the lots at the ticketing table.

The ores belonging to the tributers are sold on the mines by the same method and at the same time, this is therefore a day of some little anxiety to the miners.

On extensive mines it is quite a high day, and a substantial dinner is provided at the counting house for the agents of the mine, the samplers, and visitors connected with mining affairs.

The Chair is taken by the agent or representative of the mine selling the largest parcel of ore, who names the various parcels for sale, and receives the offers from the different smelting companies' agents for them, stating the produce and price per ton; he then selects the highest offer and declares the purchaser. A representative from all the mines selling, is usually in attendance: the produce of their ores, the list of prices, and declaration of standard fixed by the copper smelters, being looked forward to with the greatest anxiety.

Tin and lead are generally sold by private treaty, though sometimes it is ticketed for in a similar way; but all copper ores are sold in the manner described. The sale of all other minerals are matters of private arrangement.

I shall now endeavor to show you the value of the above-mentioned ores as nearly as I can obtain them:—

A TABLE OF THE QUANTITIES AND VALUE OF MINERAL ORES RAISED AND SOLD IN THE COUNTIES OF DEVON AND CORNWALL, DURING THE YEAR 1853.

Name of Ore.	Authority of Statement.	Number of Tons.	Number of Ozs.	Value. £.	s.	d.
Gold.....	Poltimore Mine Returns		130	520	0	0
Silver.....	Mining Record Office...		310,000	85,250	0	0
Nickel.....	Mine Returns*.....			600	0	0
Copper.....	Mining Record Office..	181,944		1,155,167	0	0
Tin, "Black".	Do. do. do....	8,866		277,186	0	0
Lead.....	Do. do. do....	9,694		155,434	0	0
Zinc Blende..	*a* Mine Returns*..	650		1,500	0	0
Iron.....	Do. do. * do....	12,000		10,000	0	0
Antimony.....	*b* Mine Returns*.....	40		400	0	0
Arsenic.....	Do. do. * do....			500	0	0
Sulphur.....	*c* Mine Returns*.....	1,200		1,200	0	0
				£1,687,757	0	0

The quantities marked * are only approximate, no official returns being made, but are supposed to be very nearly correct.
a The consumption of this ore has greatly increased during the last year.
b This ore has also increased in 1854.
c The demand for sulphur has fallen off in 1854.

It will be seen from the foregoing table this branch of British industry not only furnishes employment for a large and industrious population, but employs an immense capital at HOME, to the great advantage of the national prosperity, it is daily and hourly on the increase, as are the demands for the metals produced. The extension of civilization and the humanizing effects of commerce and the arts, seem fair to find constant employment for the miner for ages to come, and it is not improbable his will be one of the last, as well as one of the first trades the world ever saw.

We are informed Tubal Cain was a worker of metals; there appears to be little doubt in the earlier ages of mankind, metals of great purity were frequently found at or near the surface; many instances occur even now of copper, quite metallic, found in such situations, particularly on the shores of Lake Superior, where large masses of pure copper are discovered, which the miners are obliged to cut away with sharp chisels, as it will not blast. Gold and silver also occur in the native state at very shallow levels; indeed, these are now their principal sources, and we see tin has been worked for in the streams from the remotest times. The remains of old lead works bespeak high antiquity; it is known the Romans worked lead mines in Cumberland and Yorkshire.

The bronze tools, vessels, and ornaments discovered in the tombs and mummy caves of Egypt, prove that ancient people to have been highly skilled in the art of metallurgy; and this, combined with their knowledge of quarrying such prodigious blocks of porphyry and granite as we see they wrought, would imply a knowledge of mining. In the book of Job, chap. XXVIII v. 1, 2, 5, 6, he says,—

"Surely there is a vein for the silver, and a place for gold where they find it.

"Iron is taken out of the earth, and brass is molten out of the stone.

"As for the earth, out of it cometh bread; and under it is turned up as it were a fire.

"The stones of it are the place of sapphires; and it hath dust of gold:"

Which holds good to this day, silver being always found in veins, and gold most generally in a state of dust, among the sands or clays of ancient torrents; these passages indicate attention was at that early period attracted to these phenomena.

If antiquity entitle any calling or employment to respect, that of the miner certainly may claim it in a high degree. Long indeed has it ministered to the necessities and luxuries of man, and on this score should be held in consideration.

* That it may continue to prosper as their dangerous and difficult task amply deserves, is the sincere wish of their old and true friend,

GEORGE HENWOOD.

Art. V.—ON THE DRESSING OF ORES.*

Another lecture before the Government School of Mines, England, was devoted to describing the treatment to which stamped ore and other finely divided stuff is subjected, in order to concentrate and ultimately separate the saleable from the valueless material. The common prevailing method of washing out the stamped stuff into a pit, where it is mixed confusedly together, ought to be replaced by some system of assorting the grains according to size, which saves much labor and expense in the after processes. Such a plan is attempted in the "saver" and long tyes at Balleswidden, and some few tin mines; and in Hungary by a succession of tyes of increasing width and diminished inclination as they recede from the stamps. The apparatus for separation might be described as an inclined plane of wood, which the fine-stuff diluted to a certain amount with water, is allowed to flow downward. The specific gravity of the different substances, more or less interfered with by the friction on the under surface and by the mutual adhesion of the particles, occasions a separation of the heavier portions at the head of the inclined plane, with a gradual inferiority as the middle is passed, and the lightest and therefore the poorest, is at the "tail." The apparatus is, however, of an extremely varied character, and may be classed as 1st, the frames on which only a thin film of mineral is deposited at one time; 2d, buddles in which the mineral is intended to accumulate to a depth of from one to four feet before it is taken out for further

* From the United Mines, we hear an extraordinary account of an improvement in the 208 fm. level east, on the Hot lode. The lode is stated to be now 17 ft. big, a solid course of yellow ore, yielding thirty-five tons per fm.—the value of a fathom being at least £300. It is also expected that the cross-cut in the 220 will cut this lode in the course of next month. As the 208 has been extended nearly 100 fms. on the course of the lode, east and west of the point at which this cross-cut will enter it, and is of an average value of £100 per fm. for the whole length, there is a great probability of a rich lode being discovered in the deeper level. The water issuing from the end of the cross-cut is at a temperature of 114 deg. The men work nearly naked; and it is necessary to bring cold water in pipes from the surface to pour over them while working. The extreme heat of the water is taken as a sure indication of an immense deposit of ore.

† London Mining Journal.

treatment. The lecturer described those frames which were stationary, mentioning the cloth-covered tyes placed below stamps in gold districts, and the Cornish tin frame or "rack," to which the material is now in many cases supplied, ready mixed with water, instead of that operation being performed at the head-band by the dresser. The long frame of the continent was also noticed, and the variety used in the east of Hungary, for poor, but argentiferous lead ores. This is from 20 to 24 ft. in length, and furnished with trap-doors at the lower end. After the stuff has been let in, and has formed a sufficient deposit, the supply is stopped, and clean water let on, by the aid of which, and a gentle manipulation with a besom, the operator washes down, first through the lower trap, which is now opened, the poorest pyritous "schlich," and then obtains in a second "cover" a second quality; and lastly with a stronger flow of clean water, sweeps down the best, or leads it to its proper receptacle. Similar processes with the frames less inclined are employed for the dressing of the slimes. The ordinary kinds of buddle were then treated of, from which the deposited material, divided into three or four sorts, according to the richness has to be worked up again and again, according to its state of concentration in similar apparatus. As a variety which has come much into vogue within the last ten years, was noticed—the round buddle which, if well tended, effects a good separation, and although not so much under the command of the dresser as the rectangular buddle, is capable of working up from 20 to 30 tons of stuff in a stem of twelve hours. Much difficulty is experienced in buddling, when the slime is tenacious, whence various arrangements are made for duly suspending the fine matter in water where slime-trunks or trunkling-buddles are to be used. It may be taken as a general rule in this process, especially when the material is in a very fine state of subdivision, much practical knowledge and constant attention is needed to determine upon and carry out the system of dressing most applicable to particular mines. A model was then shown of the rotating buddle, as used in the Hartz mines. Some careful experiments had been tried by this, and it was found to answer much better than the long frame. The quantity of stuff experimented upon was 310 centners, the long frames required three men; the time occupied in all was 609 hours, while the rotating buddle only employed one man, with a consumption of 86 hours. The results were: by the rotating buddle, silver from the schlich, 5 marks 15.383 loth; slimes, 2 marks 15·672 loth = 8 marks 15·055 loth. Lead, schlich, 20 centners 48·03 lbs.; slimes, 4 centners 51·07 lbs. = 24 centners 99·10 lbs. Long frame: silver, from the schlich, 5 marks 15·023 loth; slimes 2 marks 11·060 loth = 8 marks 10·083 loth. Lead, schlich, 19 centners 78·01 lbs.; slimes 4 centners 89·08 lbs = 24 centners, 67·09 lbs. The shock-frame our miners had called a German buddle, the invention, however,

was not German at all: as a buddle this was employed in some parts of Hungary. The water generally came on this over a board filled with buttons, so as to allow an equal diffusion of the fluid; if the tension be not sufficient, the materials will not pack close together. The shock should not be given too strong, nor ought any valuable ore be seen below two-thirds of the frame; should this be the case, there must be either too much water, or the machine be in a defective state. This, however, could only be ascertained by great attention, constant care, and long practice. The "sechtervog," as used in several parts of Germany, was then shown, and several models of the different dishes as used there for the washing of ores were exhibited. The system of vanning on a common shovel, as practised in Cornwall, was then alluded to; this required some considerable practical skill and dexterity on the part of the operator. The circular bowls employed in the Brazils were also described. They were designated by the name "calao." A great objection had been raised against jigging-machines; in the first place, they require great exertion and constant attention, a considerable delay in the manipulation of ores by this process was unavoidably and constantly occurring, it being necessary to suspend the work in order to empty and fill the sieves. What was wanted was that there should be a jigging machine which did not require to be stopped, and something approaching to this had been invented by Mr. Berard, a pupil of the Mining School of St. Etienne. They were aware that the ore was the heaviest material, and consequently would sink to the bottom, but coal, which was lighter, when that had to be jigged was the most valuable. This machine, a drawing of which was in the museum, was worked by a piston, and could act continuously, the only thing was to supply the coal. It was capable of working up from 200 to 300 tons daily; it was not only employed in France, but likewise in England. In the former country it was especially valuable, the coal there being in many instances full of pyrites—so much so that had it not been for this invention, it would have been entirely valueless. Rittinger and Vogel, two Austrian miners, had made great improvements in the jigging-frames, and these had the great advantage of continuity. Rittinger, in particular, had invented the "spitzkasken," which had been found useful at Schemnitz, in the Hartz, and other mining districts. The ore was allowed to accumulate in some cases in the stamp pits or tyes, but in Rittinger's method, it was carried by a stream of water from one hopper to another, a considerable portion falling into a box underneath; this was fully described and illustrated by diagrams. With regard to silver amalgamation, he should not refer to that, as it was a metallurgical question, and therefore more properly belonged to another department. One of the common means by which they refined gold was through the instrumentality of a shallow iron pan, about

18 in. to 20 in. in diameter. Through this rises a collar with a spindle passing through it; on the top of the spindle is another apparatus attached to it by a runner of wood, that being fixed to the spindle can be rotated to an iron pan at the bottom; this has little blades of iron, and below them quicksilver. By the motion, a considerable quantity of gold is taken, the waste water is allowed to run off to another pan; sometimes the amalgamation-pan is allowed to run for a week or two. In the Alpine district of the Austrian mines, they dressed it with less quantity of quicksilver, although a greater amount of time was consumed. The mode of washing and amalgamating in the Tyrol was then described. A model of the "cradle," as used in California and Austria, was exhibited and described. But little improvement had taken place in gold dressing since the time of Agricola, who had written about 300 years since, the greatest progressive step in that direction had been made by the Russians in the Ural mountains. A praiseworthy example of the mode of dressing silver lead ores could be seen at the Tamar Consols silver lead mines, and an elaborate description of the processes employed there was given. In conclusion, the lecturer observed that in every mine the ores required a special dressing, and although they might have a knowledge of the principles, yet it was necessary that they should acquire a practical acquaintance with the details. The should not be too proud—they might learn from a buddling boy. He would advise them not to be ashamed, but to go underground and work with the pick and gad along with the miners. It was said of sailors that if they wished to know their profession, they must dip their hands in the tar bucket; and, in the same manner, if they would become miners, they must share the labors of both the underground and surface workers. The knowledge which was here acquired, would enable them, by having obtained the principles of mining to more readily understand all the operations, and with this instruction they would be able to comprehend more in one week than those who were entirely ignorant of the details would attain in a month. Science should not be neglected; every improvemont should be regarded and studied. But, in order to keep pace with the advance of the times, they must diligently and sedulously combine knowledge with practice, this last being most essential in all professions, but in none more so than those connected with mining operations.

ART. VI.—THE CHEMISTRY OF IRON. ON THE COMPOSITION OF SOME VARIETIES OF FOREIGN IRON. By F. A. ABEL, Director of the Chemical Establishment of the War Department, Great Britain.

THERE are few subjects of practical importance that have, during the last twelve months, attracted general attention in this country to the same extent as the question of the manufacture of iron ordnance. While numerous plans have been proposed, discussed, and tried for constructing cannon, either of wrought-iron, steel, or mechanical combinations of iron material of different kinds, which shall be capable of throwing larger and heavier projectiles than those hitherto used, the question at issue has gradually become one of more general interest, involving considerations intimately connected with the metallurgy of iron, in consequence of the conclusions deduced from the experience in the late war, that the conditions necessary for obtaining a durable and uniform material for iron guns are as yet far from being fully determined.

The American Government has lately published a collection of reports, containing some interesting and important observations connected with the manufacture of iron ordnance, though it does not appear that the researches carried on in that country, or the experience gained by the directors of gun foundries belonging to various continental States, have as yet effected much more than the provision of a number of data relating to the nature and quality of iron employed, the different methods of treating the metal and of casting the gun, and the effects of mechanical tests, and of the explosive force of powder upon iron ordnance. There is little doubt that the accumulation of such data, and extensive experiments suggested by their comparison, will ultimately lead to the establishment of the conditions necessary for insuring to iron ordnance uniformity and durability.

The collection in this country of such data as those referred to has hitherto been a matter of great difficulty, from the circumstances that iron ordnance were obtained by Government from various private sources; that no special conditions have been observed in the selection or treatment of metal for ordnance; that no records of the material employed by the different manufacturers have been preserved, and that no system of tests, physical or chemical, has been applied to the metal composing the guns, beyond the regulation proof to which ordnance were submitted before their acceptance from manufacturers. It is obvious, also, from these circumstances, that no uniformity in the iron guns used in this country could be expected.

Now that Government has determined to take the manufacture of iron ordnance into its own hands, the most serious obstacles to the perfection of these important arms in England are set aside, and the introduction of a complete system of testing and of record,

together with the results of a very extensive series of experiments, on a sufficient scale, which have already been commenced, will, it is hoped, furnish important contributions to our knowledge of the constitution and mode of treatment of iron, best adapted for the manufacture of ordnance.

In carrying out the system of experiment determined upon by Government, attention has been directed, in the first place, to iron reduced from its ores by charcoal, this being the material employed exclusively, in some continental States, and to a very great extent in others, in the manufacture of iron ordnance. Much stress is laid, by many authorities on the continent, upon the greater fitness for this purpose, of that description of iron than of the best hot-blast, or even of cold-blast iron, smelted with coal or coke. It appeared, therefore, naturally the first step, in comparative experiments with various materials, to ascertain the nature of the iron composing the most durable guns manufactured in those countries, and to determine, by comparative experiments here, whether guns manufactured from charcoal-iron exhibit great superiority over those made *according to the same system* of iron reduced from its ores by mineral fuel. Various specimens of foreign charcoal-pig-iron, and cannon of that metal made in France, Belgium, and Sweden, have been collected for comparative examination, and considerable quantities of charcoal-iron, procured from Nova Scotia, Sweden, and America, have been purchased, for experimental purposes. The results obtained, up to the present time, are principally those furnished by the analysis of several of these specimens; and I venture to submit these to the Chemical Society, as they exhibit some points of interest, and may also serve, to others engaged in similar inquiries, as additional means, to those already existing, of comparing the constitution of the varieties of charcoal-iron with that of other descriptions of iron.

It is unnecessary, in the present instance, to enter into analytical details; but, as various methods are employed by different chemists, for determining the most important constituents in iron, it may be advisable to furnish a brief outline of those adopted in performing the subjoined analyses.

The *graphite* was determined by digesting the finely-pulverised iron with concentrated hydrochloric acid, and boiling the residue for some time with a moderately-strong solution of potassa: the graphite was collected, washed, dried, and weighed. It was afterwards placed in a capsule and heated to redness in a muffle, until the whole of the carbon was burnt off. The weight of the slight incombustible residue which was generally obtained, was deducted from the weight of the graphite.

For the determination of the *total amount of carbon*, the iron was reduced to an extremely fine state of division; it was then first mixed with about twice its bulk of fine sand, or powdered glass, and afterwards with a mixture of chromate of lead and chlorate of

potassa. The combustion was conducted in the usual manner, a current of oxygen being frequently employed.

The proportion of *silicium* was ascertained, by acting upon the finely-divided metal with concentrated hydrochloric acid, evaporating to dryness, and digesting the residue with hydrochloric acid. The insoluble portion was collected upon a filter, washed until free from iron, dried, and ignited until the whole of the carbon was burnt off. The silicic acid thus obtained was digested with solution of potassa, after its weight had been determined. If any insoluble residue was obtained, its weight was deducted from that of the silicic acid.

To determine the proportion of *sulphur*, hydrochloric acid was allowed to act very slowly upon fragments of iron, in a suitable apparatus, and the gas generated was passed through a slightly acid solution of acetate of lead. The sulphide of lead produced was collected, washed, and ultimately weighed, as sulphate of lead.

The *phosphorus* was determined by digesting, in nitrohydrochloric acid, fragments of the metal, of the size of small peas, evaporating the solution to dryness, digesting the residue with hydrochloric acid, and separating the insoluble from the soluble portion. The hydrochloric solution was partly neutralised by sesquicarbonate of ammonia, and the greater part, if not the whole, of the sesquichloride of iron reduced to protochloride, by sulphite of ammonia. Solution of acetate of ammonia was then added in excess, and afterwards a small quantity of solution of sesquichloride of iron. The phosphate of iron was precipitated by boiling, collected, and dissolved in hydrochloric acid, and decomposed by sulphide of ammonium. The phosphoric acid was estimated in the usual manner, as pyrophosphate of magnesia.

In the following Table is represented the percentage composition of several specimens of iron, reduced from its ores by charcoal, as calculated from the analytical results:—

Composition of Pig Iron smelted with Charcoal obtained from

	Nova Scotia.			America.			France.	Silesia.	
	Gray.	Mottled.	White	Gray.	Mottled.	White	Gray.	White, *very chrystalline.*	White, *less chrystalline.*
Specific gravity,	7·120	7·540	7·690	7·159	7·540	7·675	7·000	7·531	7·605
Iron,	95·20	95·35	95·25	94·87	96·35	96·55	95·18	93·45	90·75
Combined Carbon,	—	1·72	2·96	·04	1·14	2·79	—	4·94	3·62
Graphite,	3·11	1·38	—	3·07	1·50	—	3·46	—	—
Silicium,	1·11	·26	·21	1·80	·79	·32	·80	·75	·95
Sulphur,	·01	·03	·02	trace	·01	·06	·03	trace	trace
Phosphorus,	·13	1·30	1·53	·22	·20	·17	·45	·12	3·26
Manganese,	·25	trace	—	trace	trace	trace	—	5·38	2·00
Copper,	—	—	—	trace	trace	trace	—	·24	trace
	Traces of Titanium and Cobalt.						Traces of Arsenic and Chromium	Traces of Cobalt.	

The specimens of white iron from Silesia differ from one another in several respects, and to such an extent, as to prove that they were obtained from different ores. Both were very hard and brittle; but the ore containing the largest amount of manganese exhibited a foliated structure and brilliancy of lustre, very similar to that of refined antimony, while the other specimen, rich in phosphorus, was less brilliant and far more compact. These irons were proposed for admixture with dark gray iron; but it was considered that they could not be advantageously employed for this purpose.

The French iron examined was a specimen of the metal reduced by charcoal from hæmatite-ores at the Government cannon foundry of Ruelle, and employed exclusively in admixture with charcoal-iron also reduced from similar ores in the neighborhood, for the manufacture of ordnance. It was dark, soft, fine-grained, and uniform in texture. In its general characters it was similar to the Swedish gray iron analysed, though exhibiting a superiority over the latter in reference to the amount of silicium it contains.

The specimens of American and Nova Scotia iron analysed were taken as average samples from large parcels of the metal purchased by Government for experimental purposes.

The different varieties of iron from each source exhibit such differences in their composition as are generally observed in irons reduced from the same ore under modified conditions. Both the Novia Scotia and American irons are of excellent quality, and furnish the best results when submitted to physical tests. Comparative trials are about to be made of their merits as gunmetal.

The subjoined Table exhibits the result of the analyses of four specimens, from guns of foreign manufacture.

Composition of Iron Gun Metal from

	Belgium.	France.	Sweden.	Russia.
Specific gravity, ...	7·250	7·250	7·050	7·135
Iron,.....	95·61	96·02	95·87	94·36
Combined Carbon,.....	·78	1·03	·18	·47
Graphite,.....	2·12	1·87	2·62	2·83
Silicium,.....	·99	·35	1·19	1·10
Sulphur,.....	·06	·03	·08	·02
Phosphorus,.....	·29	·45	·11	·37
Manganese,.....	·15	·25	trace	·85
Titanium.....	traces	traces	trace	trace
	Traces of Chromium, Arsenic, Zinc, and Copper.	Traces of Chromium and Tin.	Traces of Chromium.	Traces of Tin.

The Swedish metal examined has great resemblance to that composing the Russian gun, which was one of those lately captured and selected for experiment. A severe proof to which this gun was submitted, showed that the metal composing it was of excellent quality.

The Swedish metal was of a uniform light gray color, while the Russian gun exhibited a slightly mottled appearance. Both contained the graphite in a finely-divided state. It is worthy of remark, that the strength and durability of Swedish iron guns is found to be variable; which circumstance is ascribed to the very general practice of casting the guns directly from the blast furnace, instead of first submitting the metal to treatment in reverberatory furnaces.

The specimen of French gun-metal was obtained from the cannon foundry at Ruelle It resembled, in a remarkable manner, several specimens of iron gun-metal obtained from the cannon foundry at Liège, of which the composition of an average sample is also given in the above Table. Both kinds were mottled iron of very uniform character, exhibiting a short and regular fracture, and a fine and compact structure. Their specific gravities are identical, and the differences exhibited in their composition are but slight. For the preparation of the French gun-metal, a mixture of various descriptions of charcoal pig-iron, obtained at Ruelle, is made with gray pig-iron, from other similar iron works in the neighborhood (*e. g.* from *La Chapelle* and *Etouars*) with old French cannon, and with the "dead-heads" from former castings. By a protracted treatment in reverberatory furnaces, these metals undergo thorough mixture, and purification at the same time, and are converted into the uniform mottled metal above referred to. The fuel used for the remelting and mixing is Newcastle coal.

At the Belgian Government cannon foundry a certain proportion of hot-blast iron, smelted with coke, is employed in admixture with old cannon, "dead heads," and charcoal pig-iron, obtained from various smelting works, more particularly in the neighborhood of Charleroi. The fuel used for the remelting is a semi-anthracite coal from Belle Vue, in the neighborhood of Liège, and has the following percentage composition:—

Carbon,	85·56
Hydrogen,	4·20
Oxygen,	2·40
Nitrogen,	1·93
Sulphur,	1·00
Ash,	4·92

The percentage of phosphoric acid in the ash is 1·60.

The same care is taken to ensure the production of a metal of uniform structure as at Ruelle; and the excellent results obtained by the proof of the guns, and by the mechanical tests to which the metal is submitted, bear very strong evidence in favor of the superiority of iron of the particular constitution and structure produced in Belgium and France, for the manufacture of guns, over other kinds of iron, even equal to it in chemical quality.

Unquestionably, the repeated exposure of gray iron to a moderately-oxidizing action, in the reverberatory furnace, has the

effect of improving its quality, and of removing one of the impurities most objectionable in iron which is to possess tenacity and elasticity—namely, silicium. In experiments lately made, in connection with some patent processes for improving the quality of iron, it was found that the oxidizing action of air upon highly-heated iron had the effect of removing the silicium entirely, before the amount of carbon existing in the metal was diminished in any sensible degree. The close-grained and very uniform structure of the iron produced by the mixing and remelting processes, on the continent, and the very finely-divided condition in which the graphite exists in the iron, are elements affecting the durability of the gun-metal, of equal importance to the purity of iron. Some pieces of iron ordnance which have either burst upon proof, or after having been but a short time in use, and the metal composing which was of good quality and even of an unusually pure description, evidently owed their incapability to resist the force of gunpowder to the comparatively loose structure of the metal, and to the existence of the graphite in large scales. There are, moreover, various points to be taken into consideration, in connection with the *method of casting guns*, which cannot be entered into here; but which, doubtless, greatly influence their physical structure, and, consequently, their durability.

It would be premature to attempt a comparison between the merits of charcoal-iron and those of the better qualities of British cold-blast iron, as materials for ordnance, from the results of analysis alone; but thus much is certain, that iron smelted with mineral fuel may be obtained in abundance in this country, which contains not more phosphorus or sulphur than are found in average specimens of charcoal iron, and that abundant proofs already exist of the ease with which silicium may be removed from pig-iron, by judicious treatment. It may, therefore, be confidently expected that future experiments on the casting of ordnance with various kinds of iron, will prove that we are not dependent upon a supply of charcoal-iron for the production of durable guns.

As an appendix to this communication, I beg to lay before the Society the results of an analysis of a specimen of the cast-steel manufactured by Krupp, of Essen, of which such beautiful specimens were exhibited at the Paris Exposition of 1855.

This cast-steel was proposed, by M. Krupp, as a material for ordnance, as far back as 1847, and the first small gun (a 3-pr.) cast of it was submitted to severe tests, in Berlin, in 1849, and finally proved to bursting. A 12-pr. gun, of the same material, was afterwards sent for trial to this country (early in 1855), after having likewise withstood very severe tests. At about the same time, a cylinder of the cast-steel was sent from Essen, and bored by Messrs. Walker, of the Gospel Oak Works, to the calibre of

an 8-inch gun. Its breech was fitted with a cast-iron case, or jacket, the thickness of which was 10 in. at the breech, and 8·5 in front of the trunnions. The weight of the gun complete was 8 tons 5 cwt. The case was in contact with the steel barrel only at its two extremities, at the breech and the middle of the barrel; at the latter place a wrought-iron wedge-ring was fitted into the barrel, and fixed to the jacket by screws. This gun was proved at Woolwich, but bursted the first time it was fired. The probable cause of this unexpected result has been a subject of some public discussion in Germany, but there is little doubt but it was due to the injudicious form of projectile (weighing 259 lbs.) which the parties who proposed to Government the experiments with cast-steel, and provided the gun for trial, insisted upon employing for the proof.

The gun was broken into ten large pieces, and a number of small fragments. The various fractures of the cast-steel did not exhibit any imperfections to which the bursting of the gun could have been ascribed. The metal was very uniform, compact and hard. A fragment was selected for analysis, and furnished the following results:—

One hundred parts contained—

Iron,	98·05
Combined carbon,	1·18
Silicium,	0·33
Phosphorus,	0·02
Manganese,	*trace*
Cobalt and Nickel,	0·12
Copper,	0·30

No Sulphur was detected.

The specific gravity of the specimen analyzed was found to be 7·836.

The preceding paper is a condensed report of a communication read before the Chemical Society.

JOURNAL OF MINING LAWS AND REGULATIONS.

MINING LAWS OF MICHIGAN.

(Continued from page 153, Vol. I.)

Extract of Chapter 55, Title 10, Revised Statutes, 1846, referred to in Section 26 of the foregoing Act.

General Provisions relating to Corporations.

SEC. 1.—All corporations shall, when no other provision is specially made, be capable in their corporate name to sue and be sued, appear, prosecute, and defend all actions and causes to final judgment and execution, in any courts or elsewhere; to have a common seal, which they may alter at pleasure; to elect in such manner as they shall determine to be proper, all necessary officers, and to fix their compensation, and define their duties and obligations, and to make by-laws and regulations consistent with the laws of the

State, for their own government, and for the due and orderly conducting of their affairs, and the management of their property.

SEC. 2.—All corporations may, by their by-laws, where no other provision is specially made, determine the manner of calling and conducting their meetings, the number of members that shall constitute a quorum, the number of shares that shall entitle the members respectively to one or more votes, the mode of voting by proxy, the mode of selling shares for the non-payment of assessments, and the tenure of office of the several officers; and they may prescribe suitable penalties for the violation of their by-laws, not exceeding in any case twenty dollars for any one offence; but no such by-laws shall be made by any corporation, repugnant to the provisions of its charter.

* * * * * * * * * *

SEC. 7.—Every such corporation may hold land to an amount authorized by law, and may convey the same; and whenever the capital stock of any such corporation is divided into shares, and certificates thereof are issued, such shares may be transferred by endorsement and delivery of the certificates thereof; such endorsement being by the signature of the proprietor or his attorney, or legal representative; but such transfer shall not be valid, except between the parties thereto, until the same shall have been so entered on the books of the corporation as to show the names of the parties by and to whom transferred, the number and designation of the shares, and the date of the transfer.

AN ACT supplementary to an act entitled "An act to authorize the formation of corporations for mining, smelting or manufacturing iron, mineral, coal, silver, or other ore or minerals, and for other manufacturing purposes," approved Feb. 5, 1853.

SEC. 1.—*The People of the State of Michigan enact*, It shall be lawful for any mining company, associating under the act to which this is supplementary, to provide in the articles of association for having the business office of such company out of this State, at any place within the United States, and to hold any meeting of the stockholders or directors of such company at such office so provided for; but every such company having its business office out of this State, shall have an office for the transaction of business within this State, to be also designated in such articles.

SEC. 2.—The first meeting of every such association, having its business office out of this State, may be held either in this State or at such business office; and if held at such office, notice thereof shall be published for fifteen days previous thereto, in some newspaper published in the city of Detroit, and also in the county in which said office may be located.

SEC. 3.—All stock in any company organized under the law to which this is supplementary, forfeited for non-payment of assessments, and belonging to residents of this State, shall be sold within this State; such as may belong to residents of the Upper Peninsula, to be sold at the county seat of the county in which such mine is located; and thirty days' notice of such sale shall be given in some newspaper published in said Upper Peninsula: and if none be published there, then in some newspaper published in the city of Detroit; and such stock as shall belong to residents in the Lower Peninsula, shall be sold at the office of the company, if there be one in the Lower Peninsula, and if there be no such office, then at the city of Detroit, thirty days' notice of such sale being previously given in some newspaper published in the county where such sale is to be made.

SEC. 4.—All meetings and all corporate acts heretofore had by any company organized under the law to which this is supplementary, beyond the limits of this State, and within the United States, shall be held and the same are hereby made to be legal and valid: *Provided always*, That such meetings and acts would have been valid, if had within this State.

SEC. 5.—Any mining company organized and doing business under any special charter, may at any time, by a vote of the majority in interest of its stockholders, dissolve its organization, and organize under the act to which this is supplementary; and any company so organizing under said act, shall

have the right, in preference to any other company, to assume the name by which it was known in its former charter: *Provided*, it perfects its organization within sixty days after dissolving its special charter; and after perfecting its organization, according to the provisions of said act, it shall be entitled to all the rights, privileges and immunities therein contained, and the property, effects and rights of action of the company shall pass to and be vested in the company so organized under the acts to which this is supplementary, and the debts, liabilities and demands existing against the company so dissolved, shall be and remain debts, liabilities and demands against the newly-organized company, and may be prosecuted against it in like manner and to the like effect as they might have been against the company so dissolved.

SEC. 6.—Any company organized under the act to which this is supplementary, may at any time, by a vote of two-thirds in interest of its stocks holders, increase its capital, not to exceed one million of dollars, and the share of its capital stock to fifty dollars each; but nothing in this act shall be construed to give any company, organized under said act, a right to increase its number of shares to a greater number than twenty thousand.

SEC. 7.—This act shall take effect immediately.

Approved, February 6, 1856.

COALS AND COLLIERIES.

BROAD TOP COAL REGION OF PENNSYLVANIA.

At the meeting of the American Association for the Advancement of Science, Mr. J. P. Lesley read a paper on the Broad Top Coal Region in Pennsylvania. The first descriptions published of this small, isolated, semi-bituminous coal field, were necessarily very imperfect, mere notices of the fact of the existence of coal at several points within a radius of eight or ten miles, and of the reason why, namely: the existence of a deep synclinal in the heart of the Upper Silurian region, between Huntington, on the Juniata, and Bedford Springs. After an examination of two months or more by Mr. Alexander McKinley, some twenty years since, a short statement of the general outline and supposed subdivision of the field into small parallel troughs, were engrossed by Prof. H. D. Rogers in one of the Annual Reports of the Geological Survey of the State; but it was impossible to say at that time even how many beds of coal it contained, in what way the dynamic geology would develop itself, or what were the actual relations exising between the carboniferous formation in this outline and in the main body of the bituminous coal field, the edge of which extends along the summit of the Alleghany Mountains, about forty miles distant. In this condition the author took up its study, in the Spring of 1855, and has made a nearly complete survey of the seventy or eighty square miles which it covers. The levels of over nine thousand points upon the mountain have been obtained, and the structure made out with a fair approximation to accuracy. In another season the economical operations upon the mountain will be so multiplied that the minutest features of structure will become known, and a complete discussion of the fossils be possible. The present paper is intended to present only the fact and method of my survey, with its principal results. First, it has determined that the succession of the measure is not different from the system made out in Western Pennsylvania and Eastern Ohio. There is a base of carboniferous conglomerate lying upon the red shale, from one to two hundred feet thick, massive, homogeneous, ferruginous, seldom conglomeratic except as a whole, but always in certain of its layers much of it oblique in deposition, and presenting magnificent expressions of a cleavage nearly vertical which often com-

pletely masks the stratification. Over this is the series of Lower Coal Bed, then the Barren Measures, and over all the Pittsburg Coal Bed, the beginning of the Upper Series. The purple shales of the barren measures are, however, wanting—their place being supplied by ferruginous sandy shales. The coal beds are mostly identified with those of the head waters of the Ohio; not by limestone companions, for these are almost entirely absent, nor by the beds of iron ore, which are rare, and on which, at any rate, little reliance can be placed—but by their order in the series, by certain general characters, and by their relations to the two conglomerates—the one at the base of the whole system and the other at the base of the middle member of the barren measures —a rock as wide spread as the true conglomerate, and known as the Mahoning Sandstone. In the heart of this rock is a workable bed, and between it and the lower conglomerate are two others with four or five small beds—the larger beds from five to ten feet thick, the lesser ones from one to three. In the Barren Middle series, which are 400 feet thick, are several very small seams of carbonaceous matter.

The Pittsburg coal and 200 feet of the upper coal series with no workable beds as yet known, but with one thin limestone, the representative of the limestone of Greensburg, (there eighty feet thick,) occupy the four geologically highest summits of the basin, the whole thickness of coal measures in which is about 900 feet. The structural results of the survey are interesting, for they exhibit in cross sections the whole basin seven or eight miles wide, divided by a main anticlinal into two principal troughs, and these subdivided into numerous narrow synclinals, or swamps, by a system of horsebacks, not parallel to it, but traversing the basins at a low angle with their sides, and issuing as in the Wyoming and other coal fields, into the red shale valleys through the walls of conglomerate. The larger of these synclinals form northeastward normal terminal knobs overlooking the great valley of Tioga Creek, but southwestward flattened out along the crest of conglomerate which runs very obliquely across them. Their strength, however, in the red shale, has yet to be determined, and I suggest here that I know of no point of detail in structural geology more worthy of elaboration than this very difficult problem of determining by a sufficient number of thoroughly worked-out examples the law of the changes undergone by our numerous systems of small anticlinals wherever they pass out from the massive sands into the equally massive but more plastic clay formations. I well remember certain very curious geometrical speculations upon this point of Mr. Jas. D. Whelpley nearly twenty years ago, which he was led into by his development of the geology of the Pennsylvania anthracite coal fields, but which there was at that time no possibility of demonstrating, nor has been since. I believe that the discovery of this law will be in a good degree the settlement of the question, whether the wave theory of Rogers or the pressure theory of De Beaumont, is to be adopted. In this connection the curves of a Broadtop cross-section are very significant. In this cross-section it will be perceived that the *steep* slopes are commonly *opposed* to the *normal* direction—that is, face the southeast instead of the northwest — and, to my eyes, present every evidence of an origin purely compressive, and not of an origin due to fluid progression in either direction. In the Terrace Mountain alongside we have the only instance of overturn to the east which I remember to have seen. I believe that in this matter of the normal curve we have been much misled by making our sections too large—by not measuring them carefully enough—by omitting the smaller flexures, or fusing them into the larger ones, and by allowing the eye to be captured by the grander features of the waved line which has thus fallen fancifully into rythmical sequences and series of advancing waves. Every continuous Appalachian cross-section should be not only carefully measured in all its dimensions, but reduced to so small a scale that the genesis of its curves from end to end can pass at once under inspection, and be discussed without prejudice. The abruptness of some of these Broadtop anticlinals, compared with the general flatness and repose, is very remarkable, and is to be explained

so far as I can see, by nothing but side pressure. No faults have yet been discovered exceeding a foot or too; but crushes, etc., are numerous along the horsebacks. The coal is universally slipped, but seldom crushed, and hitherto has been found not only hardest but thickest in the steep dips. A very interesting fact connected with the formation of coal requires more positive proof than I can at present give it, viz.: that the sulphuret of iron *abounds in the synclinals.* Miners and engine drivers insist upon its truth, that where the bed is inclined steeply the coal is purer, and where it lies flat, the coal is soft and comparatively rich in sulphur. The protocarboeiferous coal measures beneath the red shale are represented in this region by one or more beds of black slate, containing a little coal. The subcarboniferous limestone and iron are also present, but not in much force. I hope to be able to present at the next meeting of the Association a perfect map of the region, and at least one very large specimen of a vegetable plume, not from the red shale but from the conglomerate; and some statement of the paleontology of the basin.

SOME REMARKS ON COAL OPERATIONS IN SCHUYLKILL AND OTHER COUNTIES IN PENNSYLVANIA.

The following details from the Pottsville Journal may prove of interest at this time to many of our readers :—

The supply of coal in the market holds out longer than was anticipated, particularly at the East—and from present appearances there will be but little demand for coal before the middle of April or the first of May. It will therefore be the height of folly, if not sheer *madness*, to attemptto force coal on the market, when it is not wanted.

The rates of toll have been promulgated as stated in our postscript last week—$1 80 by Railroad, with a drawback of 40 cents to New York and 20 cents to the East. By canal the toll is 65 cents—and the freights have opened at $1 90 to New York and 90 cents to Philadelphia. These rates give entire satisfaction to the trade as far as we can learn.

The Delaware, Lackawanna & Great Western Railroad and Coal Company, have fixed the following prices for their coal on board at Elizabethport:

Lump Coal	$4 25
Steamboat Coal	4 35
Broken Coal	4 40
Egg and Stove	4 75
Chesnut Coal	3 75

The freight and charges from Elizabethport to New York are 40 cents per ton.

The Lehigh Coal Company will deliver their coal by the cargo, boat weight, at New York, at $4 75 per ton, to which must be added expense of unloading, 12½ cents a ton—making $4 87½ cents.

The price delivered on board vessels at Bristol, has been fixed at	$4 00
By the Boat load at Bristol	3 75

Coal by the Boat load is always sold at the invoiced quantity. It is reweighed when put on board vessels.

The present freight on the Lehigh Valley Railroad from Mauch Chunk to Elizabethport is, per ton	$2 43
To Trenton	2 00

To which must be added the price of coal and shipping expenses.

We learn that the Lehigh operators will ask from 15 to 25 cents per ton more for their coal, on board at Elizabethport, than the Scranton prices published above, except probably for Egg and Stove, which is fixed at 50 cents per ton higher than Lump Coal. We learn that the Lehigh Lump Coal will all be required on the line, before it reaches tide water. Three-fourths of the Schuylkill Lump Coal is also consumed on the line between Pottsville and Philadelphia.

We have not learned the rates at which Lehigh Coal will be put on board, at the new shipping port at Trenton.

The Spring rates for coal on board at Port Richmond, was discussed at a meeting of the dealers held in Philadelphia on Tuesday last at Mr. Tucker's office. It was understood that the opening rates should be placed as low as the state of the trade would admit. To cover the different qualities of coal, it was understood that the minimum price ought not to be less than $3 90 on board, ranging up to $4 00, and Red Ash $4 10 to $4 25 per ton. These prices are extremely low—from 20 to 37½ cents per ton less than last year's opening rates.

Wm. Milnes, Jr., & Co., have fixed the price of their White Ash Coal on board at Port Richmond, at $3 95 per ton. The freight to New York from Port Richmond will average $1 10, the drawback of 20 cents in favor of the New York trade, makes the price of their coal delivered in New York at $4 75—the same as Lehigh Coal is offered at.

By canal, Schuylkill Coal can be sent to New York as follows:

Good White Ash Coal	$2 15
Toll on Schuylkill Canal	65
Freight to New York	1 90
Shipping expenses	5
	$4 75

Coal sent by canal always commands from 10 to 15 cents per ton more than that sent to Port Richmond, and sold to the middle men. The difference in prices constitutes the profit to the middle men, and it is always taken off the producer.

The shipments by canal from the Lehigh Region will not commence before the first of April.

The Pennsylvania Coal Company, and the Delaware and Hudson Canal Company, will not promulgate their tariff of price for several weeks yet. The Delaware and Hudson Canal does not open before the first of May—or at least no coal reaches tide much before that period, and they will await the adjustment of prices in the other regions, and frame theirs accordingly.

It is manifestly evident that there are two distinct and antagonistic interests at Port Richmond. The interest engaged in mining and shipping coal is anxious to maintain fair paying rates. The other, or middle interest, consisting of four or five firms, are buyers of coal from operators who have no wharf facilities, and who cannot sell their coal by canal. *They* consider it their interest to buy coal as cheap as possible, regardless of cost. In fact, they fully admit that such is their position, and that if operators will mine coal and are so foolish as to sell it below the cost of production, it is their own business and not the business of the purchaser. This is correct according to the laws of trade—and if it stopped here, but little fault could be found with this middle interest. But to show how this system works, it is only necessary to go to some extent into the details of mining and selling coal as practised in Schuylkill County. There are about 90 operators in this region, with only 15 wharves at Port Richmond for shipping purposes. Nearly two-thirds of the coal is sent by railroad, and a little over one-third by canal—consequently a large portion of the coal is sold to the middle men, whose interest it is to reduce prices.

All the collieries worked below the water level, (and the larger portion in Schuylkill County, within a reasonable distance of the shipping points, are below water level,) require a certain equipment to work—such as Engines for hoisting, pumping and breaking coal, engineers, firemen, &c., attendants at the slopes and shafts at top and bottom, mules to haul the coal from the breasts to the slopes &c., which together with breakage of machinery, amounts to a pretty heavy percentage on the coal produced. These collieries require to be worked up to at least two-thirds of their capacity, with the necessary equipment, to pay expenses: the Coal produced beyond that quantity gives the profit; to reduce the product below a certain point, (which

varies at different collieries,) causes a loss to the producer, even at paying prices, with full work. If he stops, his men are thrown out of employment, many go off in search of work elsewhere, and become scattered—the expense of running his engines to keep the water out, the feeding of his horses and mulesgoes on, and, in fact, nearly the whole expense of his colliery equipment has to be kept up, if he intends to start it again within a reasonable time. When he starts again it takes time to collect his men, and probably the expenses incurred in the stoppage, will eat up the profits of the business for a month or two, (or in proportion to the duration of the stoppage,) at full work and paying rates. During the shipping season of eight months, when the business is of an ordinary character, a dull season is sure to occur in the months of May, June and July, and prices begin to drag. The market becomes overstocked at these periods; then the middle interest begins to operate—they stop their supplies very suddenly—frequently without a day's notice—the colliery is reduced to half work in consequence; they try to sell—there are no purchasers; those who are engaged in mining can scarcely dispose of their own product, and they of course will not purchase. The middle man then agrees to take his coal, say at 10 cents a ton less, to pay for piling, &c. If the operator stops, he is at an expense—if the product is reduced, it don't pay, and he agrees to sell at a little less, and works on, expecting prices to advance shortly—(the coal operator has *great faith* in an advance in prices when the business is dull, but the experience of the Region proves that if they are permitted to fall below a paying point in the early part of the season, nothing but the interposition of Providence can bring them up again). In a short time the coal is stopped again suddenly—there being no demand for shipments—and down goes the price again, perhaps 10 cents a ton, until the prices are reduced below the cost of production at two-thirds of the collieries in the Region. This is a plain, unvarnished history of the Coal Trade for several years past; and the principal causes are, the peculiarity of the trade, differing in many respects from almost every other branch of business, and the existence of two antagonistic interests engaged in the trade at Port Richmond. Some of the middle men are honorable in their dealings, but it is their interest to reduce the price when it is in their power to do so—others cut deep, and grow rich, while the producer, of whom they purchase, grows poor. Nor does the fault lie altogether with the middle interest. Many of our operators force the coal on the middle men, even after they refuse it—sell at any price to meet their payments—become reckless in their business, when it don't pay, and inflict quite as much injury to the trade as the purchasing interest.

To remedy this evil, the coal organization was formed, with Mr. Tucker at its head. Our operators have agreed to fix a minimum price for coal, as a basis, a shade above the cost of production. Whenever the demand slacks off, and prices are liable to fall below this rate, authority is given to Mr. Tucker to curtail the production, say 5 or 10 per cent., sufficient to keep the supply within the demand, which reduction is to be divided *pro rata* among the different operators, according to the amount of their business, for such a period as the stagnation in the trade continues. When the demand increases, the product is increased to meet it. By this arrangement the reduction is divided amongst all—and it is not so severely felt—and prices are not permitted to fall below a paying rate. This is the nature of the coal organization of Schuylkill County; it is not to enhance the price of coal to the consumer, but rather tends to lower it; it equalizes the trade among the different interests; lessens evils which are inseparably connected with it, and which must always exist to a certain extent, from the very nature of the trade. This organization will also tend to protect the community from the numerous fluctuations that take place in the trade—such as over-stocked markets and ruinous prices one year, and a short supply and high prices perhaps the following year. If the producers are fairly paid for their investments, they will develop and increase the production equal to the demand. If their investments do not

pay, the increased production must necessarily decrease until it does pay. It is an established principle that necessary protection extended to any branch of business always increases the supply and reduces prices, while the want of protection lessens the supply and enhances prices. This will be the operation of the coal organization, if faithfully carried out. It remains for the coal trade of Schuylkill County to decide *now*, whether they will stand by their own interests, and the interests of the consumer also, by adhering to it, at least until it has had a fair trial.

We deemed this explanation necessary, because we observe that in some quarters the organization is misunderstood, and is looked upon as an attempt to advance the price of coal, when in fact it is only to equalize prices more fairly among the different branches of the trade, without any advance whatever of coal to the consumer; but, on the contrary, one of the first acts was to recommend opening the spring prices about 27 cents per ton less on board at Richmond, than the prices of last year. So sanguine do we feel of the benefits to be derived from this organization, faithfully adhered to, that we are willing to pledge our reputation as a Journalist devoted to the coal trade, that coal will sell from $1, to $1 50 per ton less in the Boston market, and about fifty cents per ton less in the New York market, than it did last winter. Last year nearly one-third the producers were broken up, and coal was high in winter. This year, under the organization, the producers can reap a profit—the market can be fully supplied, and prices kept down to a fair rate in the winter season. In fact, the organization establishes confidence between the buyer and seller as to the stability of prices, which will induce the former to come into the market and make his purchases early, by feeling assured that he runs no risk of losing on his early purchases, by a reckless reduction in prices towards the close of the season on the cut-throat principle, which cannot be guarded against when there is no unanimity in the trade, and men, from their urgent necessities, will, uncontrolled, make sales which are ruinous to themselves and their neighbors also.

With this organization, the supply of coal from Schuylkill County will be increased—without it, it must be diminished, because at least one-third of the collieries will be standing idle in the hands of the sheriff, before the close of the year. Such would be the state of the coal trade in Schuylkill County; and whatever may be said to the contrary, it will be in no better condition elsewhere, unless the producers have long purses, and can stand heavy losses.

Meeting of Coal Operators.—The meeting of the Coal Trade held yesterday, at the call of Mr. Tucker, was very largely attended, two thirds of the entire tonnage being represented. The chief object of the meeting was to adopt measures to regulate the supplies or shipments of coal to meet, but not precede the demand. Most effective measures were suggested and unanimously adopted by written agreement, which were promptly entered into and signed by every gentleman at the meeting. The power heretofore given to Mr. Tucker to regulate the shipments, was greatly enlarged and extended. On this occasion there was perfect and entire unanimity—in fact, it was the most united and harmonious meeting ever convened in the coal region; and they all united in a memorial to the Presidents of the two Carrying Companies, to extend their aid and co-operation with the trade, in securing to the organization a fair trial—and if it should fail in removing the great evils which have grown up and encompass the trade, it can then be abandoned.

"TUBBING."

Another description of plank-tubbing may be constructed to stand a pressure of 50 fms. of water,—viz., by putting cribs inside the planking.

I will explain this tubbing. The manner of putting in the wedging cribs is the same as in the former tub, only they require more strength—that is, they must be broader; in my opinion, a wedging crib should not exceed 5 inches

in depth, for this reason, that you cannot wedge a crib of greater thickness; and if the wedges are not driven well down to the bottom of the wedging crib, it is almost sure to rise in the back, and particularly when it is thick; the strength may be made up for by additional breadth. Cast-iron cribs are, perhaps, the best, although an oak crib is very good. This tub differs from the one formerly noticed, inasmuch as there are two tiers of cribs, and it may be made close-topped, or you may terminate it with a wedging crib at any good close stone above your feeder of water, without carrying the tubbing up to the pithead. The spiking cribs and inside cribs are made of good oak or elm, and proportional to the pressure: there is no general rule, and it is likely they are often put in too strong; it is always better to err on the safe side.

For a pit 9 feet diameter and 30 fathoms pressure, the wedging cribs should be 16 in. in the bed, by 5 in. deep, the other cribs 6 in. square, the planks 3 in. thick, and these inside cribs should be clad with $1\frac{1}{2}$ in. wood, flush with the wedging crib.

After the wedging crib is finished, the spiking crib is laid upon the wedging crib, $10\frac{1}{2}$ in. from the foreside of wedging crib, then the 3-inch plank spiked on to the spiking crib, next the inside crib, and above all the $1\frac{1}{2}$-inch cleading; these planks should be put on with wood pins instead of iron spikes, the cribs should be placed 12 inches apart at first, and get wider towards the top as the pressure lessens. The same operations of wedging, &c., is done with this as with the one already described in my last letter. If found suitable for a close topped tub, you must prepare to put in a wedging crib, or cribs, at the top as well as at the bottom, and "ettle" your last range of planking to come close up to the bottom of this crib. I have seen some people wedge the top wedging cribs upwards, but they are best got at, and can be repaired better, by wedging them downwards from the top side, and putting strong stays upon the wedging crib to the stone above, to prevent the pressure of water raising the crib. The only particular thing with regard to tubbing of this kind is to prepare and make the wedging crib right, and never, if possible, allow more than 1 inch behind the wedging crib for packing and wedging; if the wedging crib is done well, all is well; the planks ought to be carefully planed to the level or circle of the pit; if the joints seem not good, they ought to be taken off and made right, as there is no cure if they should be neglected in joining; the planks ought to be dry and well-seasoned, and they will swell with the water.

Crib Tubbing.—This is composed of circular cribs of wood, built one upon another, like masons work on the top of wedging crib, and as high as necessary. The wedging crib is put in the same way as before directed; when it is finished the cribs are built regularly upon it, a piece of sheathing being laid between each; the strength of these cribs should be in proportion to the pressure. I have seen these cribs only 8 inches square for a pressure of 30 fathoms of water; this was at Hebburn Colliery, where I had occasion to repair it; there was some gas behind it, and a 2-inch pipe was put in to take off the foul air and gas. I at one time turned the cock in this pipe for about 15 minutes when I was in the shaft by myself; I thought before I could get the cock open again some of the cribs would have been broken, it made them rend so.—Note: In putting in any description of tubbing, always keep holes at the bottom, or nearly so—that is, never stop the water until you have it all wedged. Crib tubbing is expensive, and requires a great deal of wedging; wedges can be made at 3d. per hundred, and cross-cut their own wood.

Iron spikes ought never to be used in any tubbing, excepting the first described, the open-top tub, where wooden treenails will not do, as the pressure is so much upon the spikes; but where inside cribbing is used the pressure is not so great on the treenails, as the inside crib saves them. My reason for not advising the use of iron spikes is, that in bad water they all waste away, and there is no other resource but to plug them up with wooden treenails, or

use copper, which is not so much injured by water. I come now to the last description of tubbing—viz., cast-iron tubbing. Cast-iron tubbing is the simplest of all tubbing. First, the wedging crib is the same way managed in this tub as with all the other tubs; the first thing is to get a good stone (of any kind if it is close in the grain) to lay it on; and, secondly, never to leave above an inch of room behind the wedging crib for packing, as the less room takes the less work, less wedges, and you are sure to make a better job. Always, to make sure work, put in two wedging cribs, in particular when the pressure is great. When the wedging cribs are finished put on the first tier of segments, even with the foreside of the wedging crib; cut pieces of deal, or any thing the height of the segments, to "spair" them up to the plumb; put a piece at every joint or segment, and let them be a little above each range, so as to be a guide to each succeeding range. Cross all the joints when you are putting them on, like masonry work. When you finish the first tire of segments, fill up the space behind with soil, or any thing of the kind which will stop a leak in your wedging crib, if any; at any rate, it will do no harm, and may do good, for you have not any remedy, unless putting in a new crib below it; half-inch sheathing must be put in at each point of the segments to wedge in, but never commence to wedge until the tub is finished. Cast-iron tubbing is almost always close-topped, and the wedging crib is put in as detailed above. I have thus, with many repetitions, which must be excused, given a homely account of the mode of tubbing off water in the Newcastle district, and if I have omitted any thing I shall be glad to rectify it.—*Correspondent London Journal.*

TIMBERING OF MINES.

A lecture was recently delivered on this subject before the Bristol (Eng.) School of Mines, of which we give a summary. The lecturer observed that the timbering of mines was, perhaps, next in importance to ventilation, as regarded the safety of the miner and the security of the working condition of the mine. The quantity of timber used in the main ways, through which the material is transported, and along which the miners have to pass to and from the places of working, depended on the condition of the roof, the hardness and consistency of which was in some instances quite sufficient to sustain ordinary pressure, without the assistance of timber. It was very important that due attention should be given to the quality and arrangement of the timber at the bottom of the shaft. Stone or brick arches were sometimes made use of, but when these were built close up to the top of the pit, the curvature of the arch, and its necessarily limited span, rendered it less commodious than what might be obtained by using strong vertical walls, with timber planking. Methods of arranging these supports, so as to have ways on each side of the shaft, were here shown. The lecturer then remarked, that as the timber in the carriage ways was to stand longer than that in the working places, it was necessary that the strongest and most durable should be selected for the carriage ways. Where the roof of these ways was very much broken, and the thill or floor not liable to heave or "creep," it might save expense and lessen danger, to build several short arches. The method of timbering horizontal excavations was simply placing two props tightly under a head piece or plank, or one prop under a short plank, called by some miners a headtree; but where the excavation inclined at an angle of 45°, as in Belgium and the North of Italy, it was necessary to use a frame of timber; this consisted of a long plank for the floor, as well as one for the roof, into both of which the props were morticed, care being taken to have the props as nearly as possible at right angles with the line of dip, as this was the direction of pressure. Since the adoption of the long-wall system of working in some of the 4 ft. or 5 ft. seams of coal in the North of England, iron props had been employed; these were circular at each end, but strengthened between by four wings. They cost about 2s. 6d., and were capable of sustaining a very great

pressure, but were difficult to draw out. The best means of supporting the goaf immediately behind the working face was by the bulk-heads or chocks, pieces of wood about 2 ft. 6 in. long, and 8 or 10 in. square, laid across each other two and two. It was necessary to have two rows of bulk-heads, 4 or 5 yards apart, each bulk being 8 or 10 yards apart, so that the rear row might be removed as the working face advanced.

A diagram, showing the method of timbering in the level, gallery, and in the inclination, in the Belgian coal mines, was exhibited; the method of pillaring or walling in the air-ways and in the goaf, and the cost per ton of coal for the latter, noticed. The kinds of timber, and the detriment to such from vitiated air and water, were also observed; larch was found to last long in water, although the fibre thereof was not much closer than that of the pine and fir; beech was also used for timbering in water. In some cases fresh water had been made use of to preserve timber. Humid air was in some instances injurious; a kind of mushroom, found to grow on the timber in humid air, tended very much to accelerate decomposition. The timber would always be most durable in good atmospheric air; hence the necessity of good ventilation for this reason, as well as for others more weighty.

MANUFACTURE OF COAL OIL.

The discovery that oil can be manufactured from coal is one of great importance. The several patents granted to parties in England have been published heretofore in this Magazine; in the following description of a patent granted to Mr. Brown in 1853, will be found some interesting particulars:

The first operation consists in distilling the coal, or other bituminous matter, in conjunction with steam, at a dull red heat; and for this purpose, the coal or other bituminous matter is introduced into a retort fitted with a steam pipe passing through a furance. The steam pipe terminates in the closed end of the retort, so that when the retort is charged with coal or other bituminous matter, and the furnace is in action, the steam pipe becomes red hot, and steam being then passed along it, in this state enters the end of the retort and rapidly unites with and expels the volatile matters arising from the coal, by which means decomposition into gas is wholly or in great measure prevented, and the amount of oily or condensable product greatly increased.

The steam pipe may, if preferred, be passed through a furnace, distinct and separate from that which heats the retort, which arrangement admits of the withdrawal of the fire from the retort, or the diminishing of its intensity at pleasure, without altering the temperature of the steam pipe. By this means the distillation of the coal or bituminous matter can either be continued altogether or in part, with the retort at a temperature below that of a dull red heat. The steam pipe may be of cast iron, or it may be of clay or earthenware. In distilling, a condenser is employed, the temperature of which should not be lower than 50 deg. Fah.

A quantity of volatile products having been thus obtained from coal or other bituminous matter, these are again subjected to distillation in a *still*, with or without the employment of a steam pipe, though the use of steam is preferred, when a large amount of paraffine is required; but where the production of oil is the chief object, steam may be dispensed with. When steam is used, it is to be brought into the still, in a superheated state, by passing it through a red hot steam pipe, disposed in the furnace or flue of the furnace which heats the still. The steam enters through the upper part of the side of the still, and promotes, as before, the distillation of the volatile matters, whilst it retards their destruction or conversion into gaseous compounds. By this means the paraffine and heavy hydrocarbonaceous oils are preserved.

During the progress of the second distillation, the products vary at the different periods of the distillation; and these are therefore to be kept separate

or received in different vessels. At first a thin oil or impure eupione oil comes over to the extent of about one-eighth of the total fluid employed; after this a thicker and heavier oil, containing paraffine, makes its appearance to the extent of from forty to fifty per cent. of the fluid employed; and lastly, a thick matter is evolved, consisting of paraffine, mixed with heavy oil; and this continues to the end of the operation, and constitutes about one-fourth of the bulk of the fluid originally used.

These three products are treated as follows: The impure eupione oil is mixed with from 5 to 10 per cent. of its weight of oil of vitroil or sulphuric acid, to which an equal bulk of water is added; bichromate of potash is next thrown in, equal in weight to one-half of the sulphuric acid employed; the whole is then heated in any convenient vessel, of wood, lead, or earthenware, and during the heating the materials are diligently stirred together. As soon as the temperature has reached 212 deg. Fah., the heating means may be withdrawn, and the whole permitted to cool and settle.

The eupione oil is next to be decanted from the acid fluid, and treated with a warm solution of caustic soda, the whole being well mixed, and afterwards left at rest for some time to settle. Lastly, the eupione oil is decanted from the alkaline fluid, and distilled, either alone, or with water, or steam, as is practised with volatile oils generally. The heavy oil, containing paraffine, is next treated either with strong sulphuric acid and peroxyd of manganese, in the proportion of 10 per cent. of acid and five per cent. of peroxyd of manganese, or it is subjected, like the eupione oil, to the action of the sulphuric acid and bichromate of potash, in the same manner and proportion as indicated for the eupione oil; after which it is treated with soda ley, and allowed to settle. The heavy oil is then decanted and distilled in the usual way; the first portions being added to the eupione oil, as consisting chiefly of that substance; the second, and by far the larger portion of the whole, is received apart under the name "lubricating oil;" whilst the last portions, being thick and of the consistency of butter, are mixed with the impure paraffine, which results from the third stage of the second distillation of the crude products, which are next treated as follows:—Having allowed the impure paraffine to remain for twenty-four hours, or longer, in a cool place, to crystallize, the oily mixture is placed in a bag or filter, similar to those in use for the separation of spermaceti from sperm oil. When the oily fluid has drained away, the paraffine is removed to a press and subjected to severe pressure, as is practised with respect to stearic acid by the makers of that substance. It must then be melted, and when cold again pressed, the oil being in both cases added to the drainings, which are to be treated like "heavy or lubricating oil." The paraffine is then melted, and the heat raised to about 400 deg. Fah., when strong sulphuric acid is to be carefully stirred into it in the proportion of from one-twentieth to one-tenth of the weight of paraffine operated upon. After boiling for a few minutes, the fire must be withdrawn, and the charred oil of the paraffine allowed to settle in the form of a black powder from the melted paraffine. This being separated, the paraffine must be boiled in water or in a weak solution of soda, after which it may be cooled, and is fit for use.

This is a very clear description of the process. Considerable quantities of very beautiful oil for illumination and lubrication are now manufactured from Breckenridge coal in Kentucky, and sold in this city. A very large manufactory of mineral oil called kerosene is in operation a few miles from New York on Long Island, and large quantities of this oil are now sold and used. It is manufactured under three patents of Dr. Gesner, granted June 27, 1854.

A patent for making a lubricating oil from asphalt—like that obtained from the pitch lake of Trinidad—has recently been obtained in England by Dr. Simpson, (he who first applied chloroform as an anesthetic agent) of Edinburgh, and Prof. W. Thomson, of Belfast. The asphalt, according to their invention, is first distilled at a temperature a little below that of a red heat. This produces a thick liquid, which is again distilled at the same tem-

perature. The second distillation brings over a more limpid liquid—a fine residuum of charcoal being left in the retort. This oily liquid is subjected to stirring or agitation in a wooden vessel, with about one-tenth of its bulk of sulphuric acid. Much of the impurities unite with the acid, and when allowed to settle fall to the bottom of the vessel. The clear liquid is then drawn off, and agitated with a caustic alkali, or mixture of quicklime and chalk, allowed to settle, and the clear drawn off. The resultant oil is then agitated with sulphuric acid, as before, and again with the alkali or chalk, allowing time after each operation for the impurities to settle, and the oil has become a pale yellow color. It is then put into an iron retort and distilled at a moderate heat, when about one-third of the quantity comes over as naphtha. The heat is then elevated, when the remainder comes over, (leaving but a small residuum of charcoal,) and is an oil nearly limpid. It is not equal to many other oils for lubrication, but one part of sperm oil mixed with nine parts of it makes a cheap and good oil for machinery. As vast quantities of oil are now employed for lubrication, and as the demand for them must increase with the progress of machinery of all kinds, a knowledge of every new source from which a supply can be obtained is of no small importance.

ANTHRACITE COAL TRADE FOR 1857.

Quantity of coal sent by railroad and canal, to May 14th:

	Railroad.		Canal.
Port Carbon	12 613 12		13,239 12
Pottsville	2,501 04		1,978 02
Schuylkill Haven	19,173 13		21,166 00
Auburn	1,332 17		000 00
Port Clinton	5,056 10		2,624 10
	40,677 16		39,008 04
			40,677 16
Total for the week		tons,	79,686 00
Total by Railroad in 1857			664,991 10
" Canal "			181,415 01
Total by Canal and Railroad		tons,	806,406 11

Shipments to same period last year:

	Week.		Total.
By Railroad	47,262 00		699,539 09
By Canal	32,421 00		175,764 11
	79,683 00		875,304 00
			846 406 11
Decrease in 1857, so far		tons,	28,897 09

LEHIGH COAL TRADE FOR 1857.

For the week ending May 14th:

By Canal		130,989 14
By Lehigh Valley Railroad		48,747 16
	For the week	179,737 10

Shipments to same period last year:

By Railroad	28,281 11
By Canal	89,583 11
	117,864 02
	179,737 10
Increase in 1857, so far	61,873 08

PINEGROVE COAL TRADE FOR 1857.

Amount transported during the Month of April, 1857:

	Month.		Total.
Union Canal	12,004 13		35,547 05
Swatara Railroad	9,171 14		28,155 11

LYKENS' VALLEY COAL TRADE FOR 1857.

	Week.	Total.
Lykens' Valley Coal Co.	2,003	16,932
Short Mountain Co.	1,267	10,669
Total,	3,270	27,601

TREVORTON COAL TRADE FOR 1857.

Total	16,454 10

BROAD TOP COAL TRADE FOR 1857.

Total	23,585

SCRANTON COAL TRADE FOR 1857.

By the Delaware, Lackawanna and Western Railroad for the week ending Saturday, May 2d:

Shipped North	3,205 08
Shipped South	8,039 13
	11,245 01

Coal over road this year:

Shipped North	54,496 77
Shipped South	87,217 00
Total for Year.....	141,713 77

CUMBERLAND COAL TRADE.

By Cumberland Coal and Iron Co.'s Railroad, to May 9th:

	tons.
Cumberland Coal & Iron Co.	38,991 00
Percy & Co.	000 00
Ætna C. Co.	5,986 11
Total	44,977 11

By Cumberland and Pennsylvania Railroad:

Frostburg Coal Co.	5 874 13
Borden Mining Co.	16,866 06
Alleghany Coal Co.	9,463 04
Union Coal Co.	3?2 14
Total	32,0?5 17

Total from the Frostburg region for the week, 2,309 03 tons; and since January 1st, 77,063 08 tons.

Total from the whole coal region for the week, ending May 9th, 4,068 14 tons; and for the year, 172,989 16 tons.

IRON AND ZINC.

ROEBLING'S PATENT WIRE ROPE.

We reprint from the *United States Nautical Magazine* the following paper read on this subject before the Mechanics' Club of the American Institute, by Mr. Wm. Henry Wallace.

Rigging.—As shipping generally furnishes the greatest market for the consumption of rope, I will endeavor to compare the wire rope with the hempen, and show some points wherein I conceive lies its superiority for this purpose.

You will please note, I refer entirely in this paper to *standing* not *running*

rigging. One advantage I will proceed to say, is, that wire ropes of equal strength with hempen, are but one-fourth part as bulky; from which I argue, that the sailing qualities of the vessel must be improved just in the proportion that the surface exposed against the wind is decreased. For example, the main stay on a steamer of 3,000 tons, if made of hemp rope, would require to be 12½ inches in circumference, whereas, if made of wire rope, the size of same stay would be decreased to only 5 inches circumference. This advantage would be appreciated on a vessel having auxiliary steam-power when making way against the wind.

Another advantageous feature, and of still more importance, is the great economy in weight, being about *fifty per cent less.* The standing rigging of a steam vessel of the same size as before, 3,000 tons, from her shrouds and stays on her lower mast, including those of top-masts, top-gallant masts, royal masts, and jib gear, would weigh, if made of hemp rope, 12.74 tons, while if made of wire rope, and same strength, the weight would be reduced to 8.24 tons, leaving a saving in favor of the wire rope of 4.50 tons; and in a sailing ship of 1,300 tons, the saving in weight would be about the same. This large saving in weight, when it is remembered that the average of the standing rigging is placed above the centre of buoyancy, must naturally increase the *stability* and particularly the *steadiness* of a ship. And this comparison will hold good in smaller classed vessels, as in an 80 ton yacht, the saving would be about .50 of a ton.

Another point I would offer in its favor—but one, however, on which, in my experience with nautical gentlemen, I find there is an unusual difference of opinion,—is, that while some maintain *the greater elasticity the better*, others hold that the *less elastic* the rigging, the better display the vessel has for her sailing qualities.

This question, I think, has been clearly settled in favor of the latter, in the published experiments made by Messrs. Newal & Co., of London, of well-seasoned hemp and wire shrouds, of equivalent strengths, under strains equal to one-third that which would break them, or more than they are usually exposed to. These experiments show, that while the *stretch* or permanent lengthening of the wire rigging is nothing compared to that of hemp, *the difference of springiness is not more than one inch in favor of hemp in the longest shrouds;* practically, therefore, the less elasticity of wire rope can be of no importance. And again, by the use of turnbuckle-screws at the end of the shrouds and stays, in place of lanyards and dead eyes, the slacking or tightening is accomplished with much greater facility and readiness, saving thereby a great deal of labor.

It has sometimes been suggested by those who have not given due reflection, whether there was not more danger from lightning in using wire rope than hemp. No, for if the bulwark irons holding the shrouds are extended to the copper, every iron shroud will become a lightning conductor, as may also be the case with the stays, so that the vessel is rendered perfectly proof against lightning.

For our naval vessels especially, wire rope is decidedly preferable, not more on account of its greater safety from fire than from the enemy's shot; and these two points alone are of sufficient importance to call for a careful consideration of the subject on the part of our Naval Bureau of Construction. Here our English friends are in advance of us; its introduction having been made in the Royal Navy, over fifteen years ago, and its adoption steadily followed both in the Navy and by the mercantile marine service, down to the present time. The steamers "Bosphorus," "Himalaya," "Parana," "Oronoco," "Bengal," "Simba," "Atrato," "Emeu," and "Persia," being among the last having more or less of their standing-rigging of wire rope.

I will take the liberty of reading to you an extract from a paper read by Mr. Andrew Smith before the Mechanical Section of the British Association for the advancement of Science, at St. George's Hall, Liverpool, in September, 1854.

"In the year 1848, the British Navy had in commission, 376 ships of every class. The expense for hempen rope standing-rigging for the above number of ships, (hempen rope, being at the rate of £40 per ton,) amounted to £114,330. In consequence of wire rope being more than twice as strong for the same weight of hempen rope, the cost for the standing-rigging of the above number of ships, made of wire rope, amounted to about £86,000, thus showing a saving of about £28,000, for one outfit of the Royal Navy; at that time wire rope was £60 per ton."

As there are now more than double the number of ships in commission, and the price of hempen rope is also doubled, £80 per ton, the cost to the country for an amount of standing hempen rigging would be £914,640.

Wire rope, on the contrary, is reduced to £10 per ton, instead of £60, as in 1848. The use, therefore, of wire rope instead of hempen, would effect a saving, in one outfit for the whole Navy, of £157,320.

Beyond this the wire rope is much more durable. Speaking from the experience of twenty years, it may be taken as three times more durable; in fact, unlike hemp, the older the wire is the stronger it gets. Several ships in the Royal Navy have been fitted from 15 to 16 years with this rope, and it is now as good as when first put over the mast-head. Hempen rope in the Royal Navy is fitted every three years, or every time the ships are put in commission. In the port of Liverpool a great number of vessels have been fitted with this rope in about 15 years; consequently, if it is admitted to be three times more lasting or durable than hempen rope, there would be a saving effected in three commissions, or nine years, for the standing-rigging of the Royal Navy, of £1,371,960.

As enormous as the aggregate saving may appear when the comparison is applied to the *Royal* Navy, I will venture the assertion, that an equally economical *pro rata* result will be arrived at when the comparison is made with *our own* Navy—and I regret that I have not been able, in the brief periodical leisure I have had to devote in preparing this paper, to obtain data and make the comparison.

The foregoing, however, will answer the present purpose of showing the economy of the wire rope, in the point of wear.

Here, however, the difference in cost between the hemp and wire rope would not be so great. The great disparity in England being, I suppose, partially attributable to the late war with Russia. Again, wire rope, unlike hempen rope, is not effected by the sudden changes of temperature: as in a northern climate, where tarred rigging gets hard, unyielding, and brittle, or under a tropical sun, where the tarred rigging becomes soft and flows, giving thereby great annoyance. Neither is it liable to those sudden changes in length, to which hemp rope is subject, and which, as every sailor knows, gives rise to inconvenience, and great labor in setting up the rigging, and to serious accidents, when, as often happens, the change takes place in a single night, in circumstances that render it impossible to set up the rigging before trouble has ensued.

I have endeavored at some length to call your attention to this field for the application of wire rope, not only because the great bulk of ropes manufactured are for this purpose, nor alone from the fact that its advantages are so numerous and well sustained abroad; but because its manufacture in this country is of modern date, and its introduction for vessels' standing-rigging not yet made, or so limited only, as not to be generally known.

However, when it shall have become developed by *our own* experience in the mercantile and naval marine service of this country, as I feel assured it soon must, its advantages will be as equally appreciated here, as they now are with our friends across the Atlantic, and its application be as common.

Bridges.—With regard to the application of wire rope to bridges, I need only to mention the "Niagara Suspension Railway Bridge," the complete success of which stands as a noble monument to the skill and persevering energy of its projector and builder, Mr. John A. Roebling, whose success is

the more gratifying, from the general distrust that was felt at its commencement.

The cables of this bridge are four in number, *each* being ten inches in diameter, containing seven strands, each strand having 520 wires of No. 9 wire gauge, or 3,640 for a cable. Sixty of these wires form one square inch of solid section, making the solid section of each cable 60.40 square inches, wrapping not included. The aggregate strength of the whole four cables being about 23,878,400 lbs.

Wire rope is also soon to become the medium for telegraphic communication, between the continents of Europe and America. If *entirely* used in this great trio of modern advancement, the telegraph, steamships, and railways, the demand would be greater than the present means at command could furnish, a hypothetical deficiency, however, that would soon be supplied.

But in addition to the foregoing, it is already in extensive use all over our country for working inclined planes on railways, for heavy hoisting in coal pits, iron and other mines, and sugar houses; far exceeding, both in economy and safety, either hide, hemp, or manilla ropes and chains.

It is equally applicable to store and warehouses, foundries, &c., for staying derricks, cranes, shears, chimneys, masts, &c.; for steering purposes on board vessels, for towlines, lightning conductors, and dumb waiters in buildings, and sash weights in windows.

On inclined planes and in mines, they are not only safer, but more economical, the degree of economy depending on other circumstances, always being, however, in direct proportion to the speed of its working, and to the consequent degree of vibration. When worked at a velocity of 8 to 12 miles an hour, driven by badly arranged machinery, continually getting out of order, it will last about two years, and pass 300,000 tons *gross* weight, over planes half a mile in length and rising one in ten. The Pennsylvania Coal Company have ropes of less size on *their* planes, performing five times the work.

Those in use on the inclined planes of the Morris Canal, are two inches diameter, drawing loads of (one hundred) 100 tons over inclinations of one in twelve, at the speed of five miles an hour, and last, in consequence of perfect machinery and good usage, seven to eight years.

Manufacture.—I will close this paper by briefly describing the powers of its manufacture, which, like the production of many other similarly valuable commodities, is simple, yet combining with much ingenuity, and a great deal of well arranged machinery.

The iron, first of all, should be of the very best quality.

The bars are first heated to a welding heat, then passed a number of times through a train of three rolls, running at a velocity of about 500 revolutions per minute, reducing the iron down from $1\frac{1}{8}$ inch in diameter to about $\frac{1}{4}$ of an inch.

Then scaled or cleaned by being placed in warm water, with a little sulphuric acid or vitriol mixed, afterwards coated with a preparation of leece or paste made of rye flour, and one end being filed down, passed through a thick drawing plate containing a series of conical shaped holes, and drawn down to No. 5 thickness of wire gauge, which is about the limit of reduction it will sustain, until softened. The process of annealing next takes place, occupying from 5 to 8 hours, and then another course of cleaning and drawing. The number of times this is repeated, depending on the fineness of wire required; for very fine wire it may be a half a dozen times.

The wires now being prepared for use, next comes the laying from them of the strands, and finally, the laying of the strands into rope.

Each strand usually consists of 3, 7, or 19 wires, the ropes having 9.49 or 133 wires.

The two most important considerations to be effected in laying up the rope are, that when the rope is made and subjected to its duty, that the tension of each wire shall be equal, and that there shall no twist take place in

the wires while being laid into strands. nor in the strands while being laid into the rope.

The first is effected by a simple mechanism of weights suspended, one at the end of each wire passing over pullies, and are slackened as the strand is forming, and the weights drawn up, and the same is the case with regard to the strands, the weights being proportionally increased.

The latter requires more machinery, but very ingeniously arranged (and which is patented by the manufacturer), being no less than a continual revolving of each wire, while the strand is being formed, and also of each strand while the rope is being laid—a striking and peculiar feature in this arrangement is, that it enables the *centre strand* to be similar to the others, *of wire*, instead of using hemp, so that where rigid ropes are required, as in standing-rigging, the strength is very materially increased.

The foregoing, I hope, may give a general idea of the process of making, but a correct knowledge of the machinery could hardly be imparted, unless by observation when in operation.

To the ends of wire rope when required, can be attached a socket, hook-clevice, turnbuckle, or any similar appendage, in a perfectly secure and safe manner.

The ropes may also be easily spliced.

MANUFACTURE OF ENGLISH IRON AND STEEL.

The Commissioners of Patents have just issued an epitome of the specifications enrolled from the earliest period to the present time, with reference to the manufacture of iron and steel, which to inventors and the industrial world generally, will be of infinite value. The amount of money lost by the re-patenting of inventions must have been enormous, and to the poorer class of inventors a source of the greatest annoyance and disappointment. The first patent appears to be that of Simon Sturtevant, in 1612, which was to continue in force for 31 years (this was about the first attempt to introduce the use of raw coal in smelting iron, in place of charcoal, which at that time was becoming scarce in England), and in accordance with the conditions of the patent he published a description of his discoveries in his *Metallica*. His process, however, appears to have failed on a large scale, and he surrendered his patent in the following year. The second was John Stevenson, in 1613, who also published a *Matallica*, and likewise surrendered his patent, as did several other inventors. In 1621, Lord Dudley obtained his patent, of which an account is given by his son, Dud Dudley, in his *Metallum Martis* (these three treatires have recently been reprinted by Thomas Simpson, of Wolverhampton, and ar published at about 7s. 6d.), Lord Dudley was enabled to make three tons per week, which was then considered extraordinary.

After a period of more than 150 years, we come to the inventions of Henry Cort, for puddling and rolling, which appears to be the next practical improvement (1783 and 1784), and we may then proceed without much interruption until we reach 1817, when the specification of Anthony Hill shows that a process, slightly analogous to, although not sufficiently so to injure the claims of Bessemere and Martien, was tried at that time, but whilst the inventor could appreciate the value of allowing the iron to be "blown or acted upon by the air," he distinctly adds that the iron "*must* be made into bar iron by puddling, reheating and rolling, or by any other known means," thus proving that the idea of blowing pig iron into malleable iron is new, although the process itself is but a modification of an expired patent.

In 1828, we come to the invention of James B. Neilson, for introducing the hot blast. In 1836, J. J. Hawkins invented the construction of the mouth of the "blowing pipe," so as to deliver the blast "in their sheets," instead of in a dense stream, so that the blast might possess a great surface in proportion to its bulk, impart its oxygen immediately to a large quantity of the ignited fuel, and also avoid the chilling effect. In the same year George

Crane introduced the hot blast with anthracite: in 1842, somewhat a similar invention, but for using cold blast, was invented by J. Palmer Budd, who employed a blast of at least 2½ pounds pressure on the square inch. In 1838, Messrs. Bradley, Burrows, and Joseph Hall, introduced "tap cinder" as a protection for the bottom and sides of puddling furnaces. In the same year Charles Sanderson, of Sheffield, patented his process for smelting at a low temperature, so as to dissolve the earthy particles of the ore without melting the metal. The iron was never in a complete state of fusion. The iron, when separated from the scoria, was removed with tongs, or in any other convenient manner.

In 1839, comes the important invention of Josiah Marshall Heath, for the manufacture of iron, and which as regards steel, was as great a stride in the manufacture, as compared with any previous process, as the process of Uchatius is at the present time. The duration of this patent was, after much litigation, prolonged by an application to the Privy Council, for seven years. Although the principle of Heath's invention had been previously described, and even as early as 1799, William Reynolds patented the employment of oxide of manganese, or manganese, in the conversion of pig iron into malleable iron or steel, but gave no proportions or details, it appears that until the introduction of Heath's patent no practical results were arrived at.

In 1839 there was a patent obtained for "obtaining metal from pyrites or mundic;" by Joseph Jennings, and as there can be no doubt that much good would result from a cheap process for treating mundic, attention might be advantageously given to the subject. In 1840 Sir J. J. Guest and Thomas Evans patented the introduction of steam into the refinery or puddling furnace, "forced upon or into, or in contact with the metal." Any suitable means might be employed.

The first practical attempt at utilizing the gases from iron furnaces appears to have been made by Robert Gardner, in 1788, although John Payne, in 1728, referred to it in a vague manner. The next claimant was Moses Teague, in 1832, who proposed to use the flame and heated gases usually discharged into the open air, for heating the charge before it was introduced into the furnace. The specification of Louis Nicholas de Meckenheim, in 1842, is too long and complicated to admit of a fair analysis, but the object was to utilize the superabundant gases cooled by blast or other furnaces, by the use of furnaces of improved construction, and receivers, retorts, &c. In 1843, A. M. Perkins patented the use of highly heated steam in place of the hot or cold air blast. The specifications enrolled since March, 1843, will form a separate series, and be referred to hereafter.—*London Mining Journal, March* 28.

ON THE MANUFACTURE OF STEEL DIRECT FROM THE ORE.

The manufacture of steel direct from the ore has long been practised in different countries, but it is only within these last few years, since the method of puddling it with pit coal has been discovered, that it has been carried to its present extent. The method of making blister and cast-steel in England is too well known to need remark, but the manner in which steel is made in Rhenish Prussia is very different, and not generally known in other countries. The quality and magnitude of the samples from Essen and Bochum, exhibited at London and Paris, is a proof of the soundness of the principle on which steel is here made; the extension and flourishing of the different establishments show that, in a mercantile point, they are highly profitable.

Pig-steel is made from the white carbonate of iron ore, either alone, or mixed with brown hematite or clay iron ore, which are smelted with charcoal in a peculiarly formed blast-furnace, the tuyers of which are so arranged, that the metal produced is quite white and crystalline, and breaks with large silvery facets, some the whole depth of the pig. This pig-steel is then, either alone or mixed with suitable charcoal pig-iron, according to the quality of the steel required, puddled in an expressly constructed furnace, with a cast-iron

bottom; when it is sufficiently decarbonized, it is formed into balls, and drawn under the hammer and rolls into rough bars, which are again welded and rolled into bars, and sold as puddled steel; this is well suited for all the purposes for which blister steel is used.

This puddled steel is treated by the cast-steel makers as blister-steel, who, by using different mixtures, make almost every quality of cast-steel. From the statistical tables (just issued) of the production of metals in the Rhenish chief mining districts, it appears that the quantity of pig-steel made in blast-furnaces in this district in the year 1856 was 7500 tons; but what more particularly deserves attention is, *that the make of rough bar-steel has increased in one year* 65 *per cent.*, or from 3800 tons, the make of 1855, to 5800 tons, the make of 1856. With this fact, is it not time that this new method be introduced elsewhere? The average price of the pig steel of this country, in the Siegen market last year, was about $53 per ton, in consequence of the price of charcoal being as high as $32 per 100 bushels; but there is no doubt that from many varieties of our ores, steel can be manufactured here at a much cheaper rate than in Rhenish Prussia, where in addition to the high price of charcoal, the ore at many furnaces costs over $4.50 per ton. It is stated that some extensive trials are at present being made in England to produce steel direct from pig-iron by melting it with a mixture of iron ore, manganese, and bar-iron; but whether the steel produced can compete in quality with that made at Essen and Bochum remains to be proved.

BOSTON IRON TRADE.

From the Third Annual Report of the Boston Board of Trade, we make the following extracts in regard to the Iron Trade of Boston.

Chain Cables.—The subject on which we have been called to report is, perhaps, of more general importance to the Board of Trade than any other, except it may be those of sound currency and safe credit. To say nothing of the fact believed to be undisputed, that iron is an article of more importance to the civilized world than any other except bread,—of more even than gold or silver,—the safety of life, as well as property, is mainly dependent on the intrinsic value of the cables used in our shipping. Our business ventures at sea, and at risk on our inland lakes, far exceed all others; and the number of persons whose lives are constantly at risk as passengers or seamen is very great. It is of the first importance, then, that proper attention should be given to the equipment of our vessels. It is not sufficient that they should be stanch and strong; that they should have good sails and rigging; that they should be commanded by experienced, brave, and faithful men, or manned by a hardy crew. Officers, men and vessels are often at the mercy of the cable, in spite of the strength in the hull and efforts on the part of the crew; as it is their main dependence to prevent them from going on a lee shore, or being driven out to sea. Not only individual ship owners and individual shippers have a stake in this matter, but the whole community is interested; and setting aside all other considerations, let us look for a moment to the view taken of it by our courts of law. Mr. Chief Justice Shaw, in a late decision said, in substance, that "in every contract of marine insurance, there must be a *fit* subject for the contract to act upon. The ship must be seaworthy; she must be tight, stanch, and strong, and in all respects well-conditioned to perform her voyage; well fitted and well equipped, well manned and well provisioned. Not only must her hull be competent to resist the ordinary attacks of wind and weather, but she must be well provided in her standing and running rigging, and also in her ground tackling. *Her anchors and cables* must be sufficient.

"The warranty of the assured that his vessel is seaworthy is absolute, and if there be any latent defect, it is immaterial whether it be *known or unknown*. If the ship prove unseaworthy from this cause, the underwriter is discharged from his liability by the *mere fact* of unseaworthiness, however

innocent the assured may have been, or however cautiously he may have acted."

The standard of seaworthiness is becoming gradually raised on account of the more perfect knowledge of shipbuilding, the more enlarged experience of maritime risks, and the increased skill in navigation. For several years, ship owners have been gradually, but generally, substituting iron for hempen cables, until, at the present day, there is scarcely a vessel of any nation that is not dependent upon iron for safety at its anchorage. The first chain cable was used in England in 1811. In the year 1820, Cotton & Hill of Boston, commenced the manufacture of chains, and for thirty years were the only concern in this country who were successful in business. The reputation of their cables is well known at home and abroad. But the low price of English chains, and the perseverance of English manufacturers in forcing upon our markets a cheaper article than could be honestly and faithfully made in this country, induced the original manufacturers to abandon their enterprise, and allow their workmen to scatter over the country to find new employment. In the course of time, however, it has become apparent to ship builders and ship owners, and to insurers, that cheapness is not safety; that many of the chains sent to the United States for sale are made of poor, often of the poorest iron. In most all cases a proof certificate is sent with the chain; but these do not give any assurance of safety to the purchasers of chain cables in the United States, because the certificates of proof are like custom-house certificates of empty liquor casks—easily and frequently transferred, and often made to do service for several articles to which they were never intended to apply.

Ship owners of the present day are not so frequently ship builders as they were some years ago, and it has become the fashion to build on speculation as well as to buy for present service. In former times the merchant of capital used to contract to have his ship built, and when she was launched, to have her rigged at the wharf under his own eye.—He used to rely upon the builder for the hull, but he never failed to see to the tackling himself. He often, too, used to assume a portion of the risk of loss, knowing the seaworthiness and the stanchness of his vessel. But in these days ships are built for sale; they are coppered on the stocks, rigged on the stocks, and all but manned and victualled on the stocks. The merchant buys his ship as she stands ready for sea the moment she slips from the ways into the water, ready to take her cargo on board; and it is not unknown that ships have been launched with part of their loading in them. Such being the state of the manufacture and sale of vessels, and the facilities of insurance being so great, it is not to be wondered at that builders buy the cheapest cables they can get. The difference between a good and a poor cable for a ship of 1000 tons, would be only about one hundred dollars it is true, but the man who builds on speculation feels that he may as well save that small sum as not, and his purchaser, knowing that his insurance only requires a certain number of cables of a certain length and size, makes no question; in fact, does not care whether they are made in England or America—whether they *are proved or not*. We learn that the attention of many of our merchants and insurance offices has been drawn to this subject lately, and that there is more anxiety felt in the business community in relation to it. In consequence of suggestions from various quarters, Messrs. Cotton, Hill & Co. have been induced to reopen their works, and they are now manufacturing chains as reliable as those formerly sold by them, although not at the prices of the poor English article.

It is necessary to inform the merchants of Boston of the propriety of looking to the actual value of the cables used on board their vessels, but it may be of use to them to point out the losses they may sustain from a little carelessness in regard to the ground tackle of their ships. In November last, the James M. Fox, a ship belonging to New York, while being towed to sea from Liverpool, grounded on the West Middle Bank; was got off uninjured, and anchored; but although in the Channel, and in good weather, the mere

flow of the tide caused both chains to part, and she went ashore again, and became a total wreck. The loss of capital caused by the use, in this instance, of cheap English chains, was more than three hundred and forty thousand dollars, ($340,000.) This is not a solitary nor an unusual loss from a similar cause. The loss on the lakes in November from the parting of cables was enormous.

In the *Daily Advertiser* of Monday, December 29, among the disasters noted, are two ships, one brig, and one schooner which parted their cables, —one of them a new ship, (St. James, of Thomaston, Maine,) in ballast, and in the river, where there could have been but very little strain upon the cables. The only remedy is in a firm and decided rule being adopted by our insurance offices, under the approbation and advice of the Board of Trade, that no vessel shall be considered as of the first class whose cables are not of the most approved standard.

We herewith attach the proof at which cablesare tested in England and in America. Since Cotton & Hill stopped their works, several of our Boston merchants in the Calcutta trade have imported the admiralty Proof Cable. These cables have to be made to order in England, and cost more than those manufactured here. It will be seen the proof is not so much as that on the American chain.

Attested Proof of Chain Cables.

Stud Link.	Proof Wood's Cables.	Admiralty Proof.	Cotton, H. & Co. Proof.	Stud Link.	Proof Wood's Cables.	Admiralty Proof.	Cotton, H. & Co. Proof.
Inches.	Tons.	Tons.	Tons.	Inches.	Tons.	Tons.	Tons.
¾	12 ½	14	15	1 ¼	36	40 ½	44
1	16	18	19	1 9-16	39 ½	43	47
1 1 16	18	20	22	1 ⅜	42 ½	47 ½	50
1 ⅛	20 ½	22 ½	25	1 11-16	45 ½	51	53
1 3-16	22 ½	25	28	1 ⅝	49	55 ½	57
1 ¼	25	28 ½	31	1 13-16	52 ½	59	61
1 ⅜	30 ½	34	38	1 ¾	56 ½	63 ½	65
1 7-16	33 ½	37	41	2	64	72	74

The amount of chain cables imported into Boston for the year ending June 30, 1856, was 4,932 tons; of anchors, 166 tons.

WM. E. COFFIN, Chairman.

Iron and Steel.—Importation in this district during the year ending June 30, 1856, (fiscal year,)—

	tons.
Bar iron,	33,705
Rod iron,	482
Hoop iron,	990
Sheet iron,	2,231
Railroad iron,	2,634
Pig Iron,	14,467
Steel,	3,052

The importation of the above (except of cables and steel) in the year 1856, is light compared with the three preceding years.

The sales of bar iron, rods, hoops and sheet iron, in 1856, were $4,000,000. Of this, perhaps $1,000,000 is of American, the balance foreign iron. Less than an average demand for machinery purposes and for ship building has prevented sales from reaching so high a figure as in the few preceding years. The business in steel has been somewhat diminished by the same causes that have influenced the sales of iron, but not to so great an extent. The sales of steel, in 1856, amount to $600,000—wholly of foreign manufacture.

The sales of American railroad iron in this market are all of the manufacture of the company, whose mill is within the city. The quantity made and sold in 1856 reached 18,000 tons; value, $1,100,000.

Very few foreign rails have been sold and delivered in Boston; but there are several houses here who import, and they have, in 1856, made considerable deliveries in the other Atlantic cities.

The sales of foreign pig iron may be stated at 10,000 tons—$320,000; very much smaller than in the few preceding years. It is difficult to determine what amount of the American pig iron transactions can be claimed as the trade of Boston, so intimately is the business connected with that of other cities. About 12,000 tons arrived in 1856.

Nails.—The manufacture of cut nails is an important branch of the industry of Massachusetts. It is conducted mostly by incorporated companies, who have factories located in Weymouth, Wareham, Taunton, Fall River, Bridgewater, Somerset, Plymouth, Newton, and, if we include a mill at Providence, R. I., and one at Pembroke, Maine, (both owned wholly in this State, and product partly sold here,) their aggregate manufacture in 1856 may be stated at 750,000 casks, and valued at $3,000,000. Of this quantity, 325,000 casks, say $1,250,000, were sold in Boston, the remainder in other New-England cities, and largely in New York.

Hardware.—The hardware trade of Boston, though not making so striking a display as is exhibited by some other branches of business, has a secure foundation, and is increasing from year to year quite as rapidly as the other departments of trade. It embraces men of intelligence, energy, and activity, who understand well its character and requirements, and whose policy is large enough and comprehensive enough to insure, not alone the success of their own individual projects, but the welfare and continued growth of the trade itself.

The number of firms in the regular trade, exclusive of dealers in iron, steel, metals, and saddlery, is about seventy, whose united sales may be safely estimated at eight millions of dollars, of which sum by far the largest part is for American manufacturers. In 1846 the united sales could not be reckoned at more than three and a half millions of dollars, of which a much larger proportion than at present was of foreign production. This fact is deserving of especial consideration.

Boston is the centre of a large manufacturing district, the products of which comprise the most important articles of iron and steel work made in the United States. This enables us to fill orders with great promptness *at every season of the year.*

In the export trade of hardware, Boston is far ahead of her sister cities, and with many of her houses it makes a large and important part of business. The superior quality of the stock from which our goods are made, not less than the excellence of their manufacture, has obtained a preference for them in South America, Africa, and Australia. With these facts in view, and the certainty that an article of the same quality can be sold at a price as low as that charged by English and German makers, there can exist no reason why this department of the business should not prove of increasing value to our city.

To Southern, Western, and Canadian buyers, it is well known that we can offer unsurpassed inducements, and it is a significant and somewhat remarkable fact, that we have in but few instances lost a customer once introduced to our market.

In conclusion, the universal good feeling prevailing amongst the members of the hardware trade seems worthy of notice, no case having arisen where a dispute has failed to be amicably settled, or where harmonious action has been refused. With earnest wishes that this good feeling may long continue, this report is submitted to the Boston Board of Trade.

Scales and Balances.—Into all branches of business, with, perhaps, scarcely an exception, enters the "just balance."

The greater convenience and rapidity, and generally the greater equability of weighing over other modes of determining quantities, has already given, and must continue to give it, the nearly universal preference.

Most wonderful have been the improvements in the *means* of weighing during the last thirty years. We hazard little in the remark, that the present business of Boston could not be transacted in less than double the time it now

takes, and at twice the expense, if our merchants were subjected to the old method of weighing with the "even beam" and "fifty-sixes."

The introduction of the "platform scale"—the invention of Mr. Thaddeus Fairbanks, in 1830—has entirely revolutionized the system of weighing, and increased in an astonishing degree the means of rapidly and accurately determining quantities for commercial purposes.

But we may here remark, that great as have been the comparatively recent improvements in the *means* of weighing, the *standard* of weights throughout our country and the commercial world is very far from possessing that uniformity so desirable in a matter of such general interest; and they will deserve well, both of the commercial and scientific world, who shall make the successful movement towards the establishment of a uniform standard, with convenient divisions of weights, to which all nations shall conform.

In Boston is manufactured and sold every variety of weighing apparatus, as to size, style, and adaptedness to every branch of business. The fine assayer's balance, the apothecary's delicate prescription scale, the grocer's, iron merchant's, hay and coal dealer's scale, the railroad track and depot scale, the butcher's and the weighmaster's beams, are but a few among the almost innumerable sorts which our dealers largely supply.

To every part of this country and the whole known world do our merchants largely circulate these indispensable accessories to trade.

There are six firms in this city nearly exclusively engaged in this branch of business, with a capital of five hundred and sixty-three thousand dollars, and whose aggregate sales amount to three hundred thousand dollars per annum.

PIONEER IRON COMPANY.

The object in view in the formation of the Pioneer Iron Company, as stated in their Report, is to engage, *solely* and immediately, in the production of pig iron, of the best possible quality, from the unequalled iron ore existing in the County of Marquette, State of Michigan, generally known as the Lake Superior Iron Mountain deposits.

From the unquestionable proof of actual experiment in various and continued tests by many iron manufactories, both as producers and consumers, which have used the ore obtained from the well-known "JACKSON MINE," and others of like quality adjoining it, the following points or facts seem by general consent to be established.

First. That the iron ore, in its native bed, is of as pure quality and the the easiest to be obtained by quarrying, of any in the United States.

Second. That no ore now used is more readily or more cheaply converted into iron than these.

Third. That the quality of iron and steel made from this ore is acknowledged to be *the best in the world*, and *will command the highest* price in any market, on account of its strength, tenacity, and susceptibility of beauty of finish.

Scientific tests of the qualities of the ore may be seen from the following certificate, which was given by Professor Jackson, upon an examination of ores forwarded by Charles T. Harvey from Marquette.

STATE ASSAYER'S OFFICE, Boston, Sept. 13, 1856.

I have made a chemical analysis of the samples of Iron on section seven, T 47, R 27, near Marquette, Lake Superior, and find it to consist of the finest and best of Iron, and, like that of the Demmara Iron Ore, of Sweden, capable of making the finest kind of Iron. It yields, by analysis, the following ingredients *per cent.*:

Peroxide of Iron,	98.02
Oxide of Manganese,	1.28
Silica,	0.44
Lime,	0.32—100.06

The gain of 6-100 of a grain is from absorption of oxygen by the small proportion of protoxide in the ore which, in analysis, is converted into the peroxide; oxide of manganese, in the proportion found in this ore, is very beneficial, and will render the iron capable of making the best of

steel. I find no titanium, phosphorus, sulphur, arsenic, chrome, or other injurious substances in this ore, *and am able to certify that it is the very best kind of iron ore known in the world, and will make good cast iron in the blast furnace*, or fine bloom and bar iron in the forge.

The ore contains 68.644 per cent. of pure iron, but the practical yield in the furnace will be somewhat less, as some oxide of iron is lost in the cinders and slag as the oré comes from the mine; it will probably yield about 60 per cent. of cast iron in the blast furnace.

(Signed,)

CHARLES T. JACKSON, M. D. *Assayer, &c.*

The annexed official statements will serve to show the strength of iron manufactured from the Marquette ores:

In Foster and Whitney's Geological Report to Hon. Justin Butterfield, Commissioner General, Land Office, Senate documents, Special Session, March, 1851, page 80, they say—

"To show the comparative quality of this Iron, we give the results of the various experiments of Professor Walter R. Johnson, on the tensity of bar iron, from localities both home and abroad."

			Strength per lbs. sq. inch.
Iron from Salisbury, Conn., by means of	40	trials,	58,009
" Sweden, "	4	"	58,184
" Centre Co., Pa., "	15	"	59,400
" McIntyre, Essex Co., N. Y.,	4	"	59,962
" England (cable bolt) B. V.	5	"	59,105
" Lancaster Co., Pa.,	5	"	58,661
" Russia,	5	"	76,069
" MARQUETTE, LAKE SUPERIOR,	1	"	89,582

While the best ore of England produced 41-100 per cent., the best ore of France 31 89-100 per cent., the best ore of Illinois 56 2-100 per cent. of pure Iron, Lake Superior produces 69 15-100.

Letter from D. B. Martin, Engineer-in-Chief United States Navy, to J. C. Dobbin, Secretary of the Navy, Washington:

OFFICE ENGINEER-IN-CHIEF, September 12, 1855.

"A piece was drawn down to 1¼ in. diameter, (round,) made into a chain link, tested in the chain-proving machine, and broke at 75¼ tons, or 169,120 lbs.

(Signed.) D. B. MARTIN, *Engineer-in-Chief.*

In addition to the above facts, it may be well to add others, by stating that these Mines are situated about 15 miles from Lake Superior, and that a locomotive railroad is so nearly completed, that it is expected to have it in readiness early the present season, by means of which ore or manufactured iron can be shipped with great facility to any portion of the country bordering on the great chain of lakes, of which Lake Superior is the largest.

There are tracts of hard-wood timber lands adjoining these Mines, not excelled in quality or quantity, of which the Pioneer Company's tract is believed to be the most desirable.

With these items of calculation established, the proposition seems self-evident, that a moderate investment, judiciously made and skilfully managed, for manufacturing charcoal pig iron from these deposits, must prove a profitable operation.

The confidence entertained in these conclusions by the Directors having led them to become identified with this particular enterprise, it is their intention to confine the expenditures of the Company to the least amount necessary to enter upon the production of the single staple of pig iron in the best manner, and to bring the business to the paying point in the shortest possible time.

When this desideratum has been gained, the Directors believe that the Stockholders will prefer that the business of the Company should be limited by its capital, and dividends thereon declared as often as may be, rather than to attempt, in event of success, an undue enlargement of operations, and the consequent risk of a diminution in the percentage of returns; the reverse of this policy having been heretofore prolific of disaster to iron concerns in this country.

The Pioneer Company's lands commence at the Jackson Iron Company's mining location, (being bounded by the same north and south line for a half mile,) and continue thence easterly along or near the line of the railroad as a continuous tract, for over six miles. It is actually traversed by about four miles of the railroad track, and the average distance therefrom of all the lands is less than one mile. The Company own in fee $3488\frac{2}{100}$ acres, and have the rights to mineral and timber on $646\frac{2}{100}$ acres more adjoining, making a total of $4134\frac{4}{100}$ acres, *or between six and seven square miles of land*, which, for

convenience of situation and quality of timber and soil, cannot be surpassed, if equalled, in the county.

The following letter was written by the gentleman who "located" or purchased of government most of these lands some seven years since, and he has consented to its being published for information of the stockholders.

L. T. MERRILL, Esq. Secretary,

DEAR SIR:—For the information of those whom it may concern, I will state that I located most of the lands included in the Pioneer Co.'s tract, in the year 1850, and from time to time afterward, with a view, then, to secure the best timber lands in the vicinity of the iron mines, my intention being to engage in the manufacture of iron myself; and so far was this plan acted upon, that part of the machinery was actually sent forward to erect works on the water-power at the eastern end of the Co.'s domain. This purpose was frustrated by my health failing me, and my intention being called to other important matters at a distance.

Knowing the qualities of the Co.'s land, by careful inspection and repeated examinations, I do not hesitate to pronounce them the best, in situation and value, for immediate use by a charcoal furnace, of any in Marquette Co., of the same area. My estimate is that they will yield from 60 to 75 cords of hard maple and yellow birch wood to the acre, besides which the pine timber, of best quality, thereon, scattered among the other, to the amount probably of two per cent., is worth in my estimation $5 per acre.

This land is also valuable as agricultural ground, and will sell, as such, for more than the original cost and interest, after the timber is entirely removed, so that the Co. will secure their fuel eventually free of stumpage cost.

Had my health been good and other circumstances not contravened my original plans, these lands would not have been disposed of to any other concern; but in consequence of the above reasons, I have consented to their sale, in consideration of the understanding that the purchasers will forthwith commence the erection of iron works, and thus put the lands to the use I designed for them, which, while it must yield extraordinary profits to the owners, will demonstrate the simplicity of, and inducements to the production of iron in that vicinity, and thus benefit that region and the whole country.

Respectfully,

CHICAGO, Feb. 25, 1857. JAMES DUNCAN.

The Directors are of opinion that it is judicious policy to secure a heavy body of lands at an early day, in that vicinity, and a handsome advance in value on their cost, within a few years, may be anticipated.

At the usual estimation that a cord of wood will produce 40 bushels of charcoal, of which 125 bushels will furnish fuel to melt one ton of iron, and assuming that Mr. Duncan's minimum figures of 60 cords of wood to the acre are correct, the Company's lands, it will be seen, will furnish fuel for nearly 80,000 tons of iron, or sufficient to supply two "stacks" for ten years. But, discounting 25 per cent. on these figures, even, and the cost of standing fuel to the Company will be merely nominal; and that, after removing the timber, the lands can be sold at more than their cost, (viz. $\$10\frac{3}{100}$ per acre,) is not improbable.

Supply of Ore and Flux.—A written contract has been made by the Jackson Iron Company with the Pioneer, by which the latter is to be supplied with ore from the Jackson iron mine at a mere nominal rate per ton, which it is believed would be less than the Company could mine the same quality on its own lands, if existing there.

This contract is for a long term of years, and will prove a valuable consideration, beyond doubt. The company doubtless has minerals on its own lands, and also privileges of mining, free of cost, on other adjacent lands, should it at any future period wish to change the source of supply.

Abundance of limestone is known to exist near the eastern extremity of the Company's lands, and can be furnished at the works, per railroad, at a very moderate cost.

Freighting Facilities.—The site of the furnace is expected to be such, that while one track takes the ore and coal to the top of the furnace, the cars of the Marquette and State Line Railroad will receive the iron for shipment at its base.

A letter received from S. P. Ely, Esq., President of the road, by one of the Stockholders of this Company, gives it as his expectation, that the road will be so far done that the locomotive will do freighting business to the Jackson mine and Pioneer lands in the month of June ensuing. Assurances have been given that the charge for freight will not exceed over the road 75 cents per ton to the Marquette, from whence it can be sent for $3 per ton (or less) to

Chicago or Detroit, and supplies, as return freight, will not cost but about the same rates, in proportion to bulk.

Cost of Furnace and Buildings.—It will be noticed in a letter from Mr. Givan, printed on another page, that the cost of the blast furnace and buildings, of which he has charge, was, in round numbers, $25,000. Although, as an ordinary rule, the same structures would cost considerably more at Marquette than near Detroit, yet the Directors are of opinion, judging from such information as can now be obtained, that the outlay required to erect a furnace of equal capacity will not exceed that sum, and they are in hopes may not equal it; but they have estimated that amount, $25,000, as requisite, and to be provided for during the present season.

COST OF MANUFACTURING PIG IRON AT THE PIONEER IRON CO.'S FURNACE—ESTIMATE FOR ONE TON.

Fuel and Materials.

125 bushels charcoal, 5 cts	$6.25	
Flux	.50	
Ore delivered	1.50	
Add contingencies	.75	$9.00
Labor and Expenses.		
Wages of 15 men at 1,50 per day; Salary of Agent; Clerk hire; Repairs; Oil, &c., &c., say $50 per day; or per ton	5.00	
Cost Freight to Chicago	3.75	
Discounts, Insurance and Commissions	2.00	10.75
		$19.75
Add *a profit* per ton of		18.25
Will make the present cash price of that quality of iron in the Western market		$38.00

To show the basis of the above calculations, a letter of Mr. Givan, General Agent of the large iron establishments at Wyandotte (near Detroit), Michigan, is appended as follows:

CHAS. T. HARVEY, Esq.,—Marquette,

DETROIT, March 3d, 1857.

DEAR SIR:—In answer to inquiries as to the results of Eureka Iron Company's Blast Furnace at Wyandotte, I would say, that by actual experiment and careful examinations, we find the following data established in reference to the making of Lake Superior ore into pig metal at our works.

The ore from the Jackson mine has yielded in our furnace over 65 per cent. of merchantable iron. It requires about one-sixth of its weight in flux, for which we use the Sibley lime-stone, found near the works. It also requires from 120 to 125 bushels of charcoal for a ton of manufactured iron. The charcoal we use is from a mixture of hard and soft wood, taken from adjacent timber lands of the Company.

The sugar maple and yellow birch undoubtedly are the best timbers for coaling purposes.

The Eureka Company has let out its coaling by contract, at from four and a half to five cents per bushel, delivered at our works, the Company furnishing the standing timber only, and have no difficulty in letting out all the coal-making we wish at those prices. Our raw ore has cost us $8 per ton, delivered on the Company's docks, from Lake Superior. Our furnace works, including stack, engine, blast apparatus, coal houses, &c., cost in even numbers, $25,000. The stack has an eight foot bosh, and turns out eight tons per day, but is capable of making ten tons in twenty-four hours. All required motive or engine power is furnished from the escape heat from the furnace. It furnishes employment for about fifteen men, independent of the coaling operations.

We have sold all the pig iron we could furnish, at $40 per net ton of 2000 lbs., discounting three per cent. on cash sales. The iron we make is acknowledged to be the very best in the market, and will command the very highest price for all purposes for which a superior iron is required.

The only drawback we find to a most profitable and satisfactory business, is the high rates to us of the raw ore, which should be furnished at a reduction of twenty-five per cent. at least, to enable us to bring our manufactured iron into general use for ordinary purposes.

Respectfully, &c.,

GEO. R. GIVAN.
Gen'l Ag't Eureka Iron Co. and Wyandotte R. M. Co.

I concur in the above statements of Mr. Givan, and can bear testimony, from the result of severe tests in my private business, that the bar and pig iron manufactured from Lake Superior ore is the best to be had in this or any other market, for all purposes where superior strength and tenacity are required.

E. B. WARD.

This concise and explicit letter, endorsed as it is by E. B. Ward, Esq., a capitalist well known for his business capacity, mechanical experience, and successful enterprise, is esteemed as giving reliable data respecting the manufacture of the *same ore* contemplated for the Pioneer Company's furnace.

The cost of labor may be some 20 or 30 per cent. higher at Marquette than at Wyandotte; but it will be noticed that the raw material costs the Pioneer Company but *one-eighth* as much as it does, at present prices, manufacturers on the lower lakes, while the cost of shipping the metal to a market is but little more, as Chicago will doubtless be the best point of demand, and from want of timber no manufacturers will exist in that vicinity.

FINANCIAL PROSPECTS.

The first call of five dollars per share having paid for the lands of the Company; excepting that which remains on long time for payment, viz., four instalments of $5,000, and interest annually during four successive years; the next two calls, due 1st June for two dollars, and 1st August for three dollars, will provide for the erection of the furnace and appendages, and the Directors calculate on having the same in readiness for use during the month of November next.

The third instalment of five dollars per share, authorized by the stockholders, will not be called until November or December next, or such portion of it as may be necessary, and will be devoted to stock the concern during the ensuing winter, with a year's supply of charcoal in advance, and also to sustain the regular operating of the Company's furnace until the opening of navigation in 1858. From that time it is to be hoped that the avails of the product of the furnace will furnish ample means to prosecute the enterprise thereafter, and allow a dividend before the close of the season.

It may be well to add, that it is intended to erect, the present season, a furnace of one "stack," capable of turning out from ten to twelve tons per day; but as soon as the business will warrant and facilities permit, it is expected to erect an additional stack, both to be driven by one engine, and by that means double the product at a less ratio of increase in expenses.

In conclusion, the directors would only say, that the foregoing gives a synopsis of the facts and figures which led them, as individuals, to think favorably of the enterprise, and become pecuniarily interested in it. It would be superfluous for them to attempt to estimate in advance the profits of the business.

The stockholders will be able, from the information contained in this circular, to decide in their own minds as to the merits of the project, and its prospects of becoming a "paying investment."

Respectfully submitted, &c.,
L. T. MERRILL, *Secretary.*

At a meeting of Stockholders of PIONEER IRON COMPANY, held in New York, April 21st, 1857,

It was voted, That the first assessment of five dollars per share having been paid, the Directors be authorized to levy two additional assessments on the capital stock of this Company of five dollars each, payable on the 1st of June and on the 1st of November next respectively; or at such other times, and in such amounts as they may deem advisable, not exceeding the amount, or averaging at an earlier date than above specified.

At a subsequent meeting of the Directors it was

Resolved, That in lieu of the assessment as proposed by the stockholders, of five dollars per share, payable on first of June next, an assessment of two dollars per share, payable on the 1st of June, and three dollars on 1st of August next, be called for on the stock; and that those paying assessments in advance of the time due, shall be allowed interest; and those who do not pay promptly, be charged interest to or from the date as the case may be, and that all payments be made in funds at par in New York city.

Resolved, That the President and Secretary be a committee to prepare a circular from this board, to accompany the notice of the second assessment, to state briefly the plans adopted in relation to the Company's business, and facts connected therewith.

The following extract from the *Lake Superior Miner*, of Ontonagon, March 7, 1857, shows the qualities of the iron produced at Marquette in a very strong light, as compared with other kinds now generally used.

Lake Superior Iron.—During the progress of the Harbor Improvement this winter, the quality of the above iron has been subjected to a very severe test. It is well known that the tenacity of iron is very greatly impaired by cold, and that iron which is quite tough at ordinary temperatures, becomes very brittle, and snaps off with a crystalline fracture if it is too severely tested when the cold is intense. Hardly any use to which the metal is put requires tougher iron than the bands placed around the butts of piles, to prevent their abrasion or splintering from the force of the hammer. When the log is driven to nearly its proper depth, the hammer, weighing 3,200 pounds, drops upon it from a height of about 35 feet. Last winter, the ordinary banding-iron was used, and great difficulty was experienced from the breaking of bands. As many as three bands have been broken in getting down a single pile, and very few lasted when the weather was cold, to put down more than three or four without breaking. They would sometimes break into two or more pieces, and would fly in such a manner as to endanger the persons of the men about the machine. This winter they used the Lake Superior Iron, with the most satisfactory results. They have driven in the very worst of weather, with the mercury 15 or 20 degrees below zero, *and yet have broken but two bands.* As many as fifty piles have been driven by a single band, which received no other injury than being flattened and expanded.

The iron is soft and fibrous, extremely malleable, and is precisely fitted to all purposes requiring tensile strength. The appearance of the fracture is different from other iron, not at all crystalline, but very white. The blacksmith remarked that he "never before saw iron that looked exactly like silver."

On the whole, we are inclined to think this is perhaps the best practical test of the comparative value of the different irons, which has yet been made.

JOURNAL OF GOLD MINING OPERATIONS.

The following extracts from the monthly report of Col. Paston, dated, Tubac, Jan. 1, 1857 will be found interesting. He says:

"When I had the honor of submitting my last monthly report, Messrs. Brunckow and Schuchard were absent on a visit to a vein of silver ore about eighteen miles west, near the Cerro Colorado, and I had not then an opportunity of forwarding the result of their examination. I have now the pleasure of stating that their impressions were most favorable of the locality, facilities of working, richness of the vein, and general indications of a metalliferous region. These impressions have been more than confirmed by several assays of ore picked up on the ground from the outcrop of the vein.

"A final and perfect assay made in the last week, shows a yield of twenty-five marcs to the cargo, or about *seventy-five* dollars to the hundred lbs. of ore. I enclose herewith the yield of an ounce of pulverized ore after passing through three several processes of heat, for the purpose of driving off other combinations, in which of course a considerable percentage of silver has been lost.

"This mine will, with your permission, be called the 'Heintzelman Mine.' The mine has been taken possession of for the Company, and Mr. Moorhman, formerly of Tumacacory, with a party of Mexican miners will attempt to open the vein, so as to secure a larger quantity of ore for smelting. The vein does not outcrop very plainly, but supposing the vein, if it is a regular one, to run north and south, a ditch will be cut east and west in hopes of striking it.

"Messrs B. and S., our excellent and reliable mining engineers, are now on the ground for the purpose of making further examination and directing the proper opening of the vein."

A postscript to the report says, "Mr. Moorhman has just come in from the 'Heintzelman Mine' for weekly rations, and states that the ditch cut there has struck a bed of ofe, but not yet the regular vein with investing rock, the 'Respaldo.' The ore is abundant and exceedingly rich; the pure silver can be cut from the ore with a knife, and the yield upon assay would far exceed that made. There is sufficient ore on the ground to run out several planchas

of silver, and we will probably rig up the blacksmith's bellows to smelt some this month, and, if possible, send you a bar of silver. Messrs. B. and S. remain on the ground; they are much interested and in high spirits, but caution me not to say much until assurance is made doubly sure. They say, it appears to be the richest mine yet found in this part of the country, but will not risk their reputation on a statement, until it is ascertained to be a regular vein—a 'Respaldo.' It is not located in a volcanic region, and there is no reason to *doubt*, but they are not *certain* of it.

"If it proves a regular vein, it is in itself an immense fortune. Mr Moorhman says a stone or adobe house must be built there immediately for storage of metal, as it is so rich that Mexicans cannot resist stealing it. This will involve an immediate outlay for hands, materials and provisions."

The report proceeds to say: "About the first of the month we found the old mines in the San Coyetano Mountains, formerly worked by a Frenchman, and called the 'Frenchman's Mines;' and as they had a high traditional reputation, we set to work there and prospected them a couple of weeks. It was considered desirable to work these mines if they would pay, on account of their close proximity to Tubac, and the abundant resources of timber on the Santa Cruz river, only about 2 miles distant; but upon assay, the yield of silver turned out so very small, that no further outlay was deemed prudent at present. Houses were constructed and possession taken, so that at a future day, if greater facilities reduce the price of getting ore, the work may be resumed. The mines are not more than a mile and a half distant from the line of Gray's Survey for the Pacific Railroad.

"In making assays, &c., our furnaces at Tubac may be relied upon as fully as mint certificates, as no report will be given until we are fully satisfied of the accuracy of the assay."

The following extract gives a glimpse of an interesting and exciting excursion of a portion of the party, in which something other than silver mines was the principal object. "After leaving the Santa Rita mines we passed up the valley eastwards towards Sonoita creek, and at six miles came to a large, bold vein of gold-bearing quartz, out-cropping, or rather thrown up into a comb, in crossing one of the tributaries of the Sonoita, where there is a fall over the vein of 12 to 15 feet. This vein has been worked by the Spaniards, or Mexican Jesuits, or somebody else, of whom we are totally ignorant. The remains of two fortifications, some arastres, &c., fully attest the value they attached to the place, and the risks and privations they had endured for the purpose of securing the precious *ore*.

"We passed on from this to the old Pueblo, on the head-waters of the Sonoita, for the purpose of hunting an old silver mine near there, worked by the Jesuits 150 years ago, but failed to succeed. Having wearied our animals in this fruitless search, we turned down Sonoita creek, and through the rich and heavily timbered bottom of that creek to the Calabazos, and thence to Tubac. We shall attempt this mine again.

"After resting a day at Tubac, we visited the country on the west, from Sopori to the Cerro Colorado, examined the vicinity and country adjacent to the 'Heintzelman Mine;' thence westward about thirty-five miles to the Babaquivera Mountains, the enclosing chain on the west, and a metallic-looking region; thence to La Aribac—examined the old mines, water, land and pasturage on that valuable estate, and thence to Tubac, having gained much knowledge of the country, and found several new veins of promising ore, which it was not practicable at that time fully to prospect.

"I may as well state at once that our principal object was to cut off a party of Apaches coming out of Sonora; but, after a week's time spent in watching, they at last gave us the dodge, by sending a party on fleet horses through by San Xavier and Tucson, when the alarm was given that the Indians had passed, and we came in, while the main body passed around by the Pichaco de los Pimos, on their way to their homes on the Gila, without molestation. The

dragoons also made a futile attempt to cut them off, but were completely foiled and thrown off guard, by following the party sent through.

"I can give no better idea of the condition of this country and Sonora than this single incident.

"It may not be amiss, in these desultory remarks, to note the improvement in Tubac and the adjacent country since our arrival. When we forced our wagons here, over the under-growth on the highway, in September last, no human being was present to greet our coming, and desolation overshadowed the scene. It was like entering the lost city of Pompeii. The atmosphere was loaded with the malaria of a rank vegetation, the undergrowth in the bottom served as a lurking place for the deadly Apache, and the ravens in the old church window croaked a surly welcome.

"Now the highroads are alive with trains and people. Commerce, agriculture and mining are resuming their wonted prosperity under the enterprise, intelligence and industry of our people. The former citizens of Tubac have returned to the occupation of their houses, set to work vigorously on their milpas, and are loud in their praises of American liberty and freedom.

"At our municipal election on Christmas, fifty-five votes were polled, and our excellent member, Ward, elected Alcalde. The number of souls in or near Tubac numbers over one hundred and fifty, and every week adds a number of families to this increasing population."

The opening of the Heintzelman Mine, makes the number of silver mines now owned by the Sonora Exploring and Mining Co. fifty.

JOURNAL OF COPPER MINING OPERATIONS.

MINNESOTA MINING COMPANY.

(Continued from page 481, vol. viii.)

Mr. Townsend's Report.—The following is the official report made to your Directors by Mr. Townsend, for the year ending the 31st of December last:—

MINNESOTA MINE, January 22, 1857.

I send herewith the general statements required by the directors in relation to the business of the mine for the past year, together with an inventory of property of all kinds on hand on the 31st of December, and such details of our operations in the various departments of mining and surface work, and such facts in regard to the present condition and appearance of the different parts of the mine as have been usually furnished heretofore, and published in your annual report for the information of the stockholders.

Extent of Mine Opened.—We have been working for the past year all the shafts except No. 7, the aggregate sinking in which has been 488 feet; so that the several shafts are now at the following depths respectively, viz:—

	feet.
Shaft No. 1, on the main vein	446
" 2, "	447
" 3, "	467
" 4, "	421
" 6, "	276
" 5, on the south vein	312
" 7, "	200
" 8, "	320
Winze from 10 to 20 fathom level	70
Total amount of sinking	2959

In the various levels we have drifted 3423 feet, and the present extent of each is as follows, viz:—

	feet.
Adit level, on the main vein	1783
10 fathom " "	1914
20 " " "	1678
30 " " "	1450
40 " " "	1340
50 " " "	920
60 " " "	387
Adit " on south vein	1010
10 fathom " "	772
20 " " "	1287
30 " " "	566
Cross-cuts and adit	985
Total extent of drifting	14,092

—making the aggregate extent of openings throughout the mine 16,051 feet, or nearly *three and a quarter miles.*

Extent and Yield of Stopes.—The year's operations have exposed 3,157 fathoms of vein surface, on which the amount of stoping performed has been 17,064 feet, or 2,844 superficial fathoms, yielding 1,177 lbs. mineral per fathom, being an increase of 287 lbs. per fathom, or about 32 per cent. over 1855, which itself was 25 per cent. over 1854—thus showing that rapid and progressive increase of yield from the stopes which is so important and characteristic a feature in our veins, proving conclusive y that they are constantly becoming richer as greater depth is attained.

Population, and Force Employed —Our population at present consists of 710 persons, viz :—537 men, 81 women, and 92 children—being an increase of 114 over the previous year.

The average number of *miners* employed the past year has been 225—exceeding that of the previous year by 47. Our entire working force consists of 481 miners and laborers, and 37 mechanics and engine men—making, with the agent and 15 subordinate officers in the various departments, the above total number of 537.

New Machinery.—Our new steam engine for No. 6 shaft fortunately reached us by the very last boat early in December, after being long delayed on the way, and when all hope of seeing it this winter had been relinquished. We have set it up with all possible expedition, and tried steam upon it already. It works to our entire satisfaction, and we expect to have it successfully employed in hoisting in three or four days time. This additional power will greatly facilitate our operations east of No. 3 shaft, and relieve the engine at that shaft in part of the heavy work required of it the past year. The outlay for these purposes, and for supplying the engine at No. 8 with water from the valley, has been considerable, and added largely to our surface expenses last season ; but they are necessary and permanent improvements, and cannot fail to influence most favorably the work and product of the present and succeeding years.

We have hired and are using the Rockland Company's stamps this winter, in addition to our own, to reduce our large accumulation of stamp-work. We hope to have it all disposed of by spring, and thus obviate the necessity for any further stamping machinery for a year to come at least.

Surface Improvements.—We have erected the past year a new store 50 x 26 feet, with a stone cellar beneath, and an office 28 x 20 feet attached ; also, substantial and comfortable houses for your agent, and the resident minister. Many of the small framed dwellings for the men have been extensively repaired, and two new ones built. Preparation of materials will also be made this winter for the church and hospital to be erected the ensuing season.

Agricultural Lands and Products.—Forty acres have been added to our clearings the past year, making nearly 250 acres in all now under cultivation. We raised last season 1,500 bushels of turnips, and 2,500 bushels of potatoes, the latter crop not being so large as heretofore, partly from unfavorable weather, and partly from the nature of the ground planted. The crops of hay and oats, however, were very satisfactory, amounting together to 130 tons.

In addition to the above, we have a large amount of land from which the wood and timber have been cut for the use of the mine, and which will be gradually cleared up and brought under cultivation as may be required.

Appearance of the Mine.—West of No. 5 shaft, between adit and 10 fathom levels, we are now working about a mass of copper estimated at 150 tons. We had heavy sand-blasts behind it without detaching it from the vein, and are now stripping the rock from it preparatory to another trial. This is near the same place where we had the large mass last winter and spring. East of that shaft, we have taken out some very good masses during the past season in the backs of 10 and 20 fathom levels. Below the point where the large mass is seen, the vein is rich ; some masses are now being cut there, near two feet thick ; and considerable heavy copper is standing in the vein, extending below the level.

In the 20 fathom level under, stoping is going on, exposing some good masses, with a promising vein. About 400 feet east of No. 5 shaft, at 20 fathom level on the south vein, we have had several fine masses, and are now cutting one there of 50 to 60 tons, and over 4 feet thick. This is a rich part of the mine.

About 150 feet east of No. 4 shaft at 50 fathom level, we are also engaged cutting a mass of 10 tons. The stopes over this level, between Nos. 3 and 4 shafts, have produced well.

At 60 fathom level, we have drifted 41 feet west from No. 3 shaft, and though no stoping has been done there as yet, we have taken out several masses, one of which weighed over a ton. As far as exposed, the vein looks well in this level.

From the appearance of 50 fathom level, we expect good stoping ground between that and 60 fathom level, west of No. 3. No. 1 shaft has been sunk during the year from 30 to 60 fathom level, where the north and south veins are united, now forming a large and rich lode, with appearance of masses.

Very little stoping has been done at 60 fathom level, between shafts Nos. 2 and 3. We shall soon be able to work at this level to good advantage, when the new steam-engine at No. 6 is fairly in operation.

The vein in the eastern part of the mine has improved considerably within the last six months.

The disorder or irregularity heretofore noticed in some of the upper levels, does not appear to exist in the lower ones. The vein is found to be regular, and produces some masses, with a large amount of stamp and barrel work. At 30 fathom level, between No. 2 and No. 6 shafts, we have a mass now exposed of over 20 tons. There is also a good mass in sight at 40 fathom level, about midway between these shafts.

From 30 fathom level near No. 2 shaft, a cross-cut has been driven 124 feet to the south vein, and 94 feet drifted west on that vein. It is expected that this drift will be connected through on the south vein to No. 8 shaft, by the work of the present winter.

At 20 fathom level, east of No. 8 shaft, a cross cut north is in progress, with a view to prove the veins on that part of the bluff, and which is now extended about 40 feet. Extensive "ancient diggings" are seen at the surface in that vicinity, to the north of the south lode, which we have usually found to be a good indication.

Shafts Nos. 2, 3, and 4, are all sinking, and we propose to sink Nos. 1 and 6 each another lift during the winter. The sinking of No. 7 was some time since discontinued by order of the Directors, on reaching the line of the disputed tract; and will not I suppose be resumed until the question of title is finally settled. Shafts Nos. 5 and 8 are down to the 30 fathom level, and we are drifting each way from them at that level. The vein has only been partially broken as yet, and appears good at the bottom of No. 5. It will probably be found advisable to sink a new shaft this year about 300 feet east of No. 6, to be worked by the new engine at that shaft.

Prospects for 1857.—From the position of the whole work underground, and with the aid of our new machinery, it is evident that a large amount of new stoping ground must be opened by the commencement of the ensuing summer—with less expense, too, than usual for drifts and shafts, from the proximity of the two veins in the eastern part of the mine. From these openings, and the appearance of the veins throughout our present workings, I think we may reasonably expect a considerable increase in the production of the mine for the ensuing year. Not much change however can be looked for in the next two or three months, until the accumulation of rock and dirt is cleared out from the eastern part of the mine; but when that is accomplished, the effect of the new engine on our monthly production will doubtless soon become apparent.

In conclusion, I may say that every thing is going on with us as favorably as usual, though the winter is severe, and the snow very deep and troublesome. We are well stocked with nearly all the supplies and materials necessary for carrying on the works until the opening of navigation. Our workmen generally are quiet and orderly. We have regular preaching on the Sabbath, and a good school through the week of about 40 scholars. And last, though not least, it gives me great pleasure to speak again in a favorable manner of the several officers of the mine, viz:—Captain Harris, Messrs. Waite, Hoyt, Haring, Flanner and White—all of whom, by faithful attention to the interests of the Company, in their respective departments, have well deserved and justified the confidence reposed in them.

J. B. TOWNSEND.

The very full and satisfactory information furnished by Mr. Townsend in relation to all the departments of the Company's work and business under his superintendence, has left your Directors but little further to add. Two of their number (Messrs. Tucker & Pearsall) visited the mine last season, as other members of the Board had done the previous summer; and were equally pleased and satisfied with the condition of things they witnessed there, and the prudent and energetic management of Mr. Townsend, as well as the faithful and capable discharge of their duties by all the subordinate officers. Some difficulty it is true occurred subsequently, by insubordinate and riotous conduct on the part of a portion of the men employed, and which occasioned some inconvenience and loss of time for a few days—but no permanent ill effects followed, tranquillity being soon restored, and we are happy to say, strictly maintained ever since.

Several of the improvements suggested and authorized by the visiting Directors the year before, were found in a state of forwardness, and have been since completed. Our spacious new store and office, of ample size to accommodate the Company's extensive and growing business, and comfortable dwelling houses for the agent and minister, are already finished and occupied; timber for the contemplated church and hospital is being prepared this winter; and our new dock and warehouse at Ontonagon, now building on the site announced as purchased with that object in our report for 1854, are under contract to be finished by 15th of May next; by which time we confidently expect the success of the harbor improvement now in progress will permit vessels to discharge our freight, and take our mineral on board at our own dock. On the whole, your Directors consider that our business and interests, in all their various departments, were never in a more satisfactory and flourishing condition—and they see no reason to doubt that the probable results of the present year will still exceed those of the last, and so continue to improve for years to come.

Before closing, it is proper to inform the stockholders of the present position of the suit of J. M. Cooper *versus* E. C. Roberts, involving our title to

115 acres of land on section 16, adjoining our mine on the west. In our last report we stated, that the plaintiff's appeal to the U. S. Supreme Court against the decision in our favor by the Circuit Court of Michigan, had been successful—that tribunal having reversed the judgment of the court below, and remanded the case back for a new trial. Since then, the case has again been brought to trial at Detroit, when, under the instructions of the judge a verdict was rendered adverse to our title—and exceptions were taken on our part, presenting, as we are advised by our counsel, entirely *new points*, on which a writ of errror was allowed by the court, and is now being prosecuted by Mr. Roberts, with the well-grounded hope that the judgment *last* rendered may be set aside, and our just rights in the case may be ultimately established.

Considering the undoubted value of this property, and the extraordinary and unjustifiable means resorted to to wrest the title from the Minnesota Company, who are, upon every principle of honor and equity, the true owners, your Directors believe it due alike to the rights and interests of the stockholders, and the cause of rectitude and fair dealing, that no proper means should be omitted nor exertions spared by us to bring this controversy to a successful issue.

The case pending at Washington will be heard at the term of the U. S. Supreme Court commencing in December next; and in the mean time a motion recently made by Mr. Cooper before that court for an order requiring us to file additional security in the sum of $25,000, against damages which he might sustain by reason of our appeal, after being ably argued and opposed by our counsel, was *denied* by the court.

Your Directors have only to add in conclusion, that having exercised their best judgment in the discharge of the important duties intrusted to them, and given their earnest and careful attention to the business of the Company for the past year, they trust that the results now announced will be as satisfactory to the stockholders as they certainly are gratifying to themselves.

All which is respectfully submitted.

JOHN C. TUCKER, WILLIAM HICKOK,
MOSES A. HOPPOK, WILLIAM E. DODGE,
WM. PEARSALL, JR, ENOCH C. ROBERTS,
Directors.

New York, March 11th, 1857.

On motion, the REPORT was accepted, and ordered to be printed for the use of the Stockholders.

Also, article 11 of the BY-LAWS was *amended*, so as to provide for the payment hereafter of regular semiannual dividends on the first of May and 1st of November in each year, and the closing of the transfer books for every such dividend.

Appendix.—For the advantage of ready and convenient reference, the following TABULAR STATEMENT of the Company's business from the commencement of its operations, is re-produced from our last Report, and continued to include the results of the past year:—

Year.	No. of men employed.	Expenditure	Tons mineral produced.	Value in copper.	Capital paid in	Dividends paid.
1848	20	$14,000	6½	$1,700	$10,500	
1849	60	28,000	52	14,000	16,500	
1850	90	58,000	103	29,000	36,000	
1851	175	88,000	307½	90,000	3,000	
1852	212	108,000	520	196,000		$30,000
1853	280	168,000	523	210,000		60,000
1854	392	218,000	763	290,000		90,000
1855	471	281,000	1,434	550,000		200,000
1856	537	357,000	1,859	702,000		300,000
Total		$1,320,000	5,568	$2,082,700	$66,000	$680,

[Since the date of the foregoing report, and before going to press, we have received late numbers of the "*Lake Superior Miner*," published at Ontonagon by GEORGE D. EMERSON, Esq., Mining Engineer, from which we extract, for the *further* information of our stockholders, the following editorial articles, written after his personal inspection of the mine; and the statements in which are fully corroborated by advices received from Mr. Townsend himself since the annual meeting]

(*From the "Lake Superior Miner," of February 28th*, 1857.)

"The most astonishing developments have recently been made at the Minnesota mines. It would seem that wonders were never to cease on that location. Geological dogmatists were somewhat surprised when they began to take copper in large masses from the south lode of the Minnesota and from the National mines. It was against the rule which they had established in relation to veins, because a vein proper must cut the formation, and could not, as they declared, lie between two kinds of rock so completely dissimilar as trap and conglomerate. The subsequent works on the Minnesota have proved this vein to be one of the most valuable in mineral of any yet discovered upon the globe.

"Another peculiar feature among the phenomena of this lode, has been discovered by the late openings. They are finding immense masses of copper *in the conglomerate* under the vein. A few days since, when we were in the mine, this was showing in the most marked manner at several points. In the 20 fathom level, east of No. 5 shaft, south lode, the regular sheet of copper had been taken from the foot wall, and the yield at this point had been very great. The masses were from 12 to 18 inches thick. Strings of copper were cut off, that seemed to branch into the conglomerate. These were followed, and led immediately to very large masses, some of which were of the thickest copper ever before taken from the mine. One piece which was cut up, presented a face of bright copper cut by the chisel *three feet and nine inches* in thickness. It was so thick that it could not be handled in the mine without again dividing longitudinally, or *splitting*, as they called it. Thus the mass showed two flat surfaces, at right angles with each other, of bright copper cut by the chisel.

"This point in the mine has been extremely productive. Some 200 tons of large masses have been taken out of the conglomerate under the lode, besides the enormous yield of the vein itself overlaying it. In one place the copper extended into the conglomerate as far as *sixteen feet* south of the foot wall.

"An occurrence of copper in all respects similar, is found to the west of No. 5, under the adit level. Besides the masses in the regular vein, which was also extremely rich at this point, they had taken only 40 or 50 tons out of the conglomerate. The foot wall was perfect, as in the other case, and the strings leading into the conglomerate were quite small, and very slightly attached. But by trifling labor they uncovered a series of masses going up and down, with an eastward inclination, for the height of 70 or 80 feet—and going out of sight both above and below. It was at once apparent that they had something very valuable, but they had no conception of the immense thing, which a few days' work disclosed. At one convenient point they broke away behind the copper, so as to get in a sand blast of five or six kegs of powder. They then stripped the mass farther, and fired again without result. Again they fired nine kegs, and the mass remained unmoved. Breaking the rock around for a considerable distance, 18 kegs were shot off without effect—and again 22 kegs, and the copper entirely undisturbed at any point. After further clearing, 25 kegs were shot off under the copper, and it was thought with some effect. But a final blast of 30 kegs, or 750 pounds, was securely tamped beneath the mass, and fired. As soon as the hot air and powder smoke had time to clear away, a mass of copper, some 45 feet in height, and from 3 to 5 feet in thickness, apparently very pure, and which will probably weigh 300 tons, had been shot out, and was ready for cutting up. The blast had torn the immense body from its bed, without exhibiting a sign of bending or cracking it in any place, so great was its thickness and strength. It was torn off from other masses which still remain in the solid rock.

"About one hundred feet to the east of this is another large mass, which several parties are exposing, and from present appearances, it may even exceed in size the last named one.

"These are near the point of the great *counter lode* of which we have spoken heretofore, from which 300 to 400 tons of copper have been taken; and the ground in the vicinity has unquestionably yielded the greatest amount of mineral ever taken from the earth in the same space. Its occurrence has been in three distinct forms—1, in the counter just named; 2, in the regular vein; and 3, in the conglomerate rock under the vein.

"At the No. 2 shaft, they are sinking below the 60 fathom level, and experience great difficulty in getting through the copper which they encounter. It was feared that they would be compelled to turn the shaft entirely out of the vein to enable them to sink.

"But little heavy copper has hitherto been taken from the eastern part of their workings. This has been mainly owing to the want of power for clearing the mine of water and dirt. The new engine at No. 6 shaft has been in operation for some five weeks. It is the most powerful machine on the location—works admirably, and is doing a splendid duty. It has already made room for 25 or 30 miners in that part of the ground. Masses of thirty to forty tons weight are now uncovered in the back of 30, near No. 6, the most eastern shaft. A mass was also found in the back part of the 40, near the same shaft. In the 60, west of No. 3, drifting has been made a little over a hundred feet, disclosing excellent ground. Connection has also been made between Nos. 2 and 3, distant some 230 feet, showing several important masses.

"This is a rapid summary of the new things to be seen under ground at the Minnesota mines. With a thousand tons of copper in sight, a considerable part of which is thrown down—with their abundant openings and ample machinery—what do you think, reader, will be the product of the Minnesota for the coming year? *We* opine, that the most sanguine expectations hitherto formed will be exceeded."

(*From the "Lake Superior Miner," of March 7th*, 1857.)

"If our friends below wish the description of a Lake Superior specimen, the existence of

which we agree to vouch for, let them read the paragraph below, and they will find it to be something worth republishing.

"There is now in the Minnesota mine, between the adit and the 10 fathom level, a single detached mass of apparently pure metallic copper, which is some *forty-five feet* in length, and in the thickest part as much as eight or nine feet in thickness. If it is pure, as it appears to be, it contains probably more than *five hundred tons* of metal; and is certainly worth as it lies, more than *one hundred and fifty thousand dollars.*"

EUREKA MINING COMPANY.

Since the last annual meeting of the Stockholders, the operations of the Eureka Mining Company have progressed—perhaps not to so great an extent as could have been wished; yet when the events which have occurred are considered, we think the results are fully equal to what we had any right to expect.

It will be recollected that, at the time of the last annual meeting, but one furnace and a calciner had been completed. On the 22d of April following a second furnace was put in operation. Our experiment with these proving successful, we then resolved to erect two additional furnaces, which were completed, and put in operation during the months of September and October; but finding that one calciner was inadequate to supply all the furnaces, one of the latter was used as a calciner until a new one could be built. Had the four furnaces been completed at the beginning of the year, our product of regulus would have been greatly increased.

During the month of June last a survey of our property was undertaken by our general agent, and it was found that the line, hitherto supposed to be the boundary at one end of the property, and up to which our workings had been extended, was incorrect, and that some eighty feet in length on the vein, beyond the supposed line, should be included within our bounds. It becoming necessary to suspend mining in this quarter, that part of the mine became flooded; consequently, our openings had to be pushed in the opposite direction, and for a time, until the drivages could be sufficiently extended, the supply of good ores was small. But the discovery of ores, resulting from these explorations, has exceeded any thing that could have been expected, as will be seen from the general agent's and mining captain's reports.

The sudden and unexpected great fall in the price of ores, which took place during the summer, has in some measure diminished our cash receipts. This fall, however, occurred at a time when the production was at the smallest point.

It will be seen from the accompanying statements, that notwithstanding the late completion of our furnaces and the interruption of our mining operations, there has been a considerable increase in our assets over last year. Our improvements have all been paid for, and every liability extinguished (excepting drafts for current expenses at the mine and not matured). Our stock of supplies and cord-wood at the mine is ample, and larger than at any previous time; and that on the delivery of the regulus now in transit, there will be a considerable cash balance in the treasury.

It seems proper in this connection to intimate the policy which may be adopted for the future, should it be deemed expedient, after the proper development of the mine, to extend our improvements by the erection of more furnaces. It is thought that such expenditure should only be made from the funds in hand accruing from the sales of material produced, and after adequate dividends have been made to the stockholders.

Subjoined are the extracts from the Reports of the General Agent, Mining Captain, and Superintendent of the Smelting-Works; also,

Statements of

Ore, Regulus, and Copper sold and delivered,
Receipts and Expenditures,
Assets and Liabilities,

All of which is respectfully submitted.

By order of the Board, JOSIAH MACY, *President E. M. Co.*

From Captain Trenwith's Report of March 12th, 1857.

We have discovered copper for nine hundred feet in length. There are thousands of tons of copper opened before us; how many thousands of tons, I cannot say, but as far as has been proved, every foot of gossan covers a mass of copper ore. We shall be at less cost the next year than the last, as, at the beginning of the year, the raceway and the levels in the mine were in bad order.

From T. J. Esterbrook's (our General Agent) Report of March 13th, 1857.

The developments of ore are very great. The bulk of ore opened to view during the last eight months is left standing, and but little more taken out than is necessary for further explorations.

Every place now open gives a fine showing for copper, and there is exposed to view a supply for a long time to come. Ores are not taken out faster than they can be used, for the reason that they would waste materially and deteriorate in value when exposed to the weather.

The new south-western workings, near the dwelling-house, are so far very satisfactory, proving the existence of ores in that quarter also, and giving the strongest indications that ore extends from the eastern to the western ends of the mineral portion of our property.

Alex. Tripped, Superintendent of the Smelting-Works, reports, under date of March 13th, 1857, in regard to the additions to the Smelting-Works, &c., as follows:

Buildings.—The additions made to the buildings belonging to the smelting-works were considerable. They consist of a new calcining-house, engine-house, a large drying-kiln, carpenter and backsmith's shop, and several large sheds for sheltering materials, covering in the whole almost half an acre of ground. A large wood-shed, capable of holding 4,500 cords, is to be erected shortly.

Fixtures.—The new fixtures consist of the third and fourth furnaces, with a stack in common, and a calcining-furnace, for which a stack was built on the adjoining hill. All the four smelting furnaces have been built on a new principle—combining "step-grates" with the so-called "reserved combustion." This was experimental, but it is satisfactory to say that this construction has proved to work very well. I shall continue to give my attention to further improvements in the furnaces.

Machinery.—There was also erected a set of machinery for crushing and sawing. The water power was taken partly from the overshot raceway (leading the water to the saw-mill at the mine), by means of troughs, on a trussel work 600 feet in length, and 26 feet high, and partly from auxiliary raceways. The tail-water is carried off by an underground raceway to the property line. The water-wheel is a back-action wheel of 36 feet in diameter, and calculated for twelve-horse power.

The power of the crusher and the rest of the machinery is appropriate to the water-wheel. It has been tried and works well. As soon as the tram-road, which brings the sawed wood alongside the furnaces, is completed, the saws will come into permanent operation.

Wood.—A matter of the utmost importance is the cord-wood, as a considerable part of our success depends on the quality and dryness of the fuel. As a proof, it may be sufficient to say that, in a daily average for six months (in summer), the produce was 25 per cent. more than in six months of the winter season, when the wood is generally wet; it is, therefore, necessary that the wood be well seasoned for at least six months, and that a portion be kept under shelter for use in wet weather. For this reason, the stock on hand ought to be kept up to 3,500 or 4,000 cords.

Brickyard.—I have manufactured, during the past year, upwards of 500,000 red bricks, and about 50,000 fire-bricks. The manufacturing of the latter was very difficult without a crusher and a powerful press. These deficiencies are now remedied, and I believe that as good a quality of fire-brick

can be made here as the nature of the clay will admit; so that the amount of northern brick used will be but small.

MATERIAL SOLD AND DELIVERED FOR THE YEAR ENDING MARCH 21ST, 1857.

Ore	485 $\frac{911}{2000}$	tons, averaging	23 per cent.	56,615 89
Regulus	260 $\frac{1978}{2000}$	" "	50 "	66,659 88
Copper	3766 lbs.			882 50
Total				$123,158 33

ROCKLAND MINING COMPANY.

Another business year in the history and progress of our enterprise having elapsed, and brought around our third Annual Meeting, your Directors are again called upon, in the discharge of their important and responsible duties, to present to the Stockholders a detailed Report of the mining operations which have been prosecuted during the last twelve months, and the results which have been (or are to be) realized therefrom—together with a statement of the Company's financial condition, and its prospects for the current year, as indicated by the present appearance of the works and veins throughout the various openings in the mine.

As it gave them pleasure to state in their report for 1855 that the reasonable expectations of success with which they entered on the duties of *that* year had not been disappointed, so it affords them equal satisfaction *now* to announce not only a continuance, but an increased degree of success for the *past* year—fully justifying as it does the opinion then expressed by your Directors, "that the mine would thenceforth sustain itself, and that it would not be necessary to call in any further assessments on the capital stock."

That this result should have been accomplished at the *Rockland Mine* in so brief a period as three years from the commencement of the work, and with the small comparative expenditure of $40,000 of its capital, are facts we believe but rarely paralleled in the history of the most successful mines; and may justly inspire the stockholders with a high appreciation of the value of their investment, and confident anticipations of substantial and satisfactory returns in the shape of dividends at no very distant day.

Product and value of the mineral.—The whole quantity of mineral produced (or rather dressed, stamped, and weighed off) from January 1st to December 31st, 1856, was 489,938 lbs. or about 245 tons of mass, barrel, and stamp copper, in the following proportions, viz:—

Masses	50 per cent.		249,774 lbs.
Barrels	28 "		140,497 "
Stampings	22 "		99,667 "
Total			489,938 lbs.

This product is an excess of 108 tons (or nearly 80 per cent.) over that of 1855—and would doubtless have exceeded 100 per cent. if the stamps had been at work the whole time; but they did not get fully into operation till last spring, and were discontinued about the 1st November, from considerations of economy—the supply of stamp-work being insufficient to keep them going constantly through the winter, and costing too much to run them only occasionally, and have them frozen up in the intervals. Within that period, however (eight months), they stamped 1,700 tons of rock—and about 300 tons more had been raised and were on hand on the 31st December; so that, had the latter been stamped and included in the returns, the quantity actually *produced* by the mine for the year would have appeared some 12 to 15 tons more than above stated.

As it is, the gross value of the year's product, estimated at 73 per cent. yield of pure copper, and at the average rate of our sales to the present date, amounts to about $95,000.

Receipts, yield, and proceeds of mineral.—The amount of mineral forwarded to the close of navigation last fall (including that left over at Ontonagon the previous season), was 384,891 lbs., or nearly 192½ tons—all of which was smelted at Detroit, and produced 282.067 lbs. pure copper, being a yield of 73.48 per cent—or nearly 3½ per cent more than the product of 1855.

Of these receipts, 256,248 lbs. have been sold to date, realizing the sum of $68,524 36, or an average of 26¾ cents per lb.—This is nearly one cent per lb. *less* than the average sales of 1855, in consequence of the heavy although temporary decline in the copper market last summer, and but for which our sales would have amounted to some $3,000 more. The balance of 25,819 lbs. still on hand, is worth, at the present market price, about $7,350.

It is a circumstance of some interest and significance, that although the proportion of mass copper smelted was considerably *less* than for 1855, the percentage yield of pure metal has been 3½ per cent. *more*—showing, either that the whole product was of a higher degree of purity, or that the barrel and stamp-work were much cleaner dressed than heretofore—or probably *both* these causes have contributed to the result. This increase in the yield just about offsets the deficiency in the average rates of sales, and equalizes the two years in the latter respect.

Bills receivable	$11,138 12	
Sales not collected	1 805 14	
Cash on hand	4,504 52	
		$16,947 78

Mineral on hand.—The quantity of mineral on hand on the 1st of January and 1st of March last, from the actual returns, and the additional product estimated to 1st of May ensuing, are shown by the following statement, viz:—

Mineral reported on hand January 1st, 1856		25½	tons.
Do.	raised from Jan. 1st to Dec. 31st, "	245½	"
		270½	"
Do.	forwarded to close of navigation "	192½	"
Do.	remaining on hand Jan. 1st, 1857	78½	"
Do.	produced in January "	23	"
Do.	do. February "	30½	"
Do.	estimated in March and April "	68½	"
	Amount on hand May 1st, 1857	200	tons.

To this amount might fairly be added some 20 to 30 tons more in the accumulated stamp-stuff now also on hand—but as that will come in to augment the returns of the present and succeeding months, now that the stamps are again in operation, it is purposely omitted from the foregoing statement.

The net value of these 200 tons mineral, estimated at the percentage yield and average rate of sales of the past season, is about $70,000—all which will probably come forward and be made available within the ensuing three months.

Property at the Mine.—Mr. Townsend's inventory of property of all kinds at the mine, estimating buildings and other improvements at their cost, and supplies, materials, &c. at cost and charges, shows the following valuation, viz:—

Buildings of all kinds, roads, surface and underground railroads, 22 acres of clearings, and other permanent improvements, estimated at cost	$16,447 00
Personal property, including steam-engine, stamps and other machinery, mining and agricultural tools and implements, live stock, and materials and supplies of all kinds, as per inventory	18,245 00
Total amount	$34,692 00

This statement shows an increase in improvements and personal property at the mine, since last report, of about $8,000—and being now well provided in these respects, but little additional expenditure will be necessary for the current year, except for the purchase and erection of a steam-engine and machinery now imperatively required for hoisting from the different shafts, keeping the mine free from water.

General Statement, May 1, 1857.—The amount of the Company's resources, or assets, as derived from the foregoing statements, the amount of its liabilities, and the total surplus of its property—showing altogether the general condition of its business and finances as nearly as possible on the first of May ensuing, are as follows, viz:—

Resources.

Ingot copper on hand	$ 7,350 00
Bills and debts receivable	12,443 26
Cash in Treasurer's hands	4,504 52
Mineral on hand at the mine	70,000 00
Property of all kinds at do	34,692 00
	$128,989 78

Liabilities.

Balance of indebtedness Jan. 1st, 1857	$52,057 21	
Expenditure from Jan. 1st to May 1st, is 4 months at $7,000 per month	28,000 00	
		80,057 21
Total surplus of property		$48,932 57

Deducting from this surplus the *whole* amount of property at the mine (although part of it will be available towards the current expenditure), we have about $14,000 to represent the probable nett earnings of the mine since the first of January, or at the rate of $3,500 per month. This cannot however be considered as any criterion for the earnings of the present and succeeding months, for reasons already partially given; but which are more fully and satisfactorily stated, with much other interesting information, in the following official report made to your Directors by Mr. Townsend for the year ending 31st December last, and his correspondence of a still later date addressed to the Secretary.

MR. TOWNSEND'S REPORT.

The following is the official report made to your Directors by Mr. Townsend, for the year ending the 31st December last.

ROCKLAND MINE, January 16th, 1857.

"With the expiration of the year 1856, it again becomes my duty to give you a statement of the business of the mine for the past twelve months, with the present condition and appearance of the works, and our plans and prospects in reference to the operations of the ensuing year.

Extent of Mine opened.—Since my last report, two new shafts (Nos. 5 and 6) have been opened upon the south vein, and that vein reached by the cross-cut or adit level connecting the works on the two veins. No. 5 shaft is located where the adit cross-cut intersects the south vein. No. 6 is 340 feet further east.

The aggregate amount of *sinking* in the six shafts during the year has been 342½ feet—making the present depth of each as follows, viz:—

Shaft No. 1 is sunk	260 feet.
Do. " 2 "	84 "
Do. " 3 "	197 "
Do. " 4 "	114 "
Do. " 5 "	185 "
Do. " 6 "	74 "
Total depth of shafts	910 feet.

In the different levels and cross-cut, 1338 feet of *drifting* has been done, making their respective lengths at present, as follows, viz:—

First level is opened	643 feet.
Second do. "	863 "
Third do. "	535 "
Adit do. "	565 "
Adit cross-cut "	545 "
Total extent of drifts	3151 feet:—

making the present aggregate extent of openings throughout the mine 4061 feet, or a little over three fourths of a mile.

Extent and yield of Stopes.—On the vein surface exposed by the sinking and drifting of the past year, 4795 feet of *stoping* has been performed, yielding 489,918 lbs. of rough copper in masses, barrel-work, and stamp-work—being at the average rate of 612 lbs. of mineral from each fathom (or 36 square feet) of vein surface.

Cost of Mining Work.—The rate of miner's wages, and the average contract prices paid for the different kinds of work performed as above during the year, have been as follows, viz:—

Average wages of miners (including board)	$42.23	per month.
Do. cost of sinking	11.17	per foot.
Do. do. drifting	7.53	"
Do. do stoping	3.25	"

Works in Progress.—Shaft No. 1 is 60 feet below 10 fathom level, and we shall commence to drive the 20 fathom level this month—No. 3 is 13 feet below the same level, and is now sinking—No. 4 will be continued soon to the same level—No. 5 is 95 feet below the adit level, and preparation is being made to drift, at that depth, for the second level on the south vein.

On the north or main vein, the adit level is now extended 138 feet east of No. 4 shaft, and we have just commenced to drive it west of No. 1 also, with the view of connecting eventually with No. 2 shaft, and thus extending the work in the western portion of the mine. The 10 fathom level is driven 151 feet east of No. 3 shaft, and will also be extended west of No. 1, with the same ultimate object.

The work on the south vein is advancing steadily, though but little stoping has been done there as yet.

Force employed.—The entire force at present employed in the departments of work at the mine, consists of 153 persons, viz :—1 captain and assistant, 74 miners, 6 carpenters, 3 blacksmiths, 62 laborers, 2 teamsters, and 2 enginemen—making, with 28 women and 30 children, a total of population of 211 persons (being an increase of 75 since last report) now resident on the Company's location, and sustained by their works.

Appearance of the Mine.—In the adit level on the south vein, the vein is not large, though quite regular and easy to work compared with the north vein. East of No. 5 shaft, we took out two tons of mass copper, and barrel and stamp-work from other places in the level, and the work of the present winter we expect will show a considerable improvement. This vein can be traced through westwardly to the workings at the Minnesota mine; and we feel confident that when sufficient depth is attained, it must and will produce well. Indeed there are many places on the same vein at the Minnesota, and of equal extent, that have heretofore produced no better.

On the north vein, some stoping has already been done above the adit level east of No. 4 shaft producing several fine masses of copper the past year. We have just finished cutting up, at that point, another mass of twelve tons; and the vein now being exposed by the stopes is highly promising for more.

In the 10 fathom level on same vein, east of No. 3 shaft, we are now passing a mass of copper of unknown extent, but probably 10 to 15 tons in sight. In the same level, a few feet west of the same shaft, we have another mass exposed in part, but extending above the stopes, several tons however being in sight. The vein throughout this entire level is much better than in the adit level above.

The above are the principal masses exposed to view at present, but there are places in the bottom of the adit level, east of No. 1 shaft, where a strong vein evidently goes down, which will be reached by the work of the ensuing year; and no doubt, as we get greater length on the vein, further and equally satisfactory discoveries will be made.

Prospects for 1857.—It is always extremely difficult and uncertain, from the very nature of the case, to estimate for a year in advance the amount of copper likely to be raised from *any* mine; especially as that result depends so much upon the method of working adopted, and the facilities possessed for working to advantage. In our case for instance, the light returns for the last two months were not owing to any unfavorable change in the veins, but to our prudent plan of working; more of the force having been engaged in opening ground for the ensuing summer, and a less proportion employed at stoping, and this will continue to be somewhat the case until spring, although the masses already exposed will no doubt materially increase the returns of the next three or four months.

In regard to facilities too, the depth and extent of the mine now demand the aid of steam machinery to prosecute the work with proper vigor and efficiency. Early measures should therefore be taken to provide a steam engine of suitable power, to be located at No. 4 shaft, for the purpose of hoisting from Nos. 3 and 4, and to which pumping machinery should also be attached. No aid however can be derived from this source before next fall—but in the mean time, when the ground is more fully opened by the work of the present winter, and the stamps are again in operation, we shall doubtless show a considerable improvement in our monthly returns. In fact, I have no hesitation in saying, that I consider our prospects now fair for an important increase in production for the present, over the past year—I will not say how much—but it may far exceed any estimate I might venture to make at present.

It is the opinion of very many in the country that the Rockland should earn a dividend the present year, and for my own part I can see nothing to prevent it; especially if the present price of copper should be maintained. The expenses aside from actual mining will not be large, except for the steam-engine and hoisting and pumping machinery, which I hope the Directors will conclude to erect with the least possible delay.

The mining work has been, as heretofore, under the immediate charge of Captain Edward Jennings, of whose experience and ability it is unnecessary for me to speak, as he is well known to many of the Directors. The surface work and building department have been under the charge of Mr. William Peck, of whose fidelity and attention to the interests of the Company it gives me pleasure to speak most favorably.

JOURNAL OF SILVER AND LEAD MINING OPERATIONS.

SONORA EXPLORING AND MINING COMPANY.

The strip of Mexico south of the Gila, purchased by the United States for $10,000,000, was formerly the seat of considerable silver-mining operations by the Spaniards, and its wealth must consist chiefly in mines, for its soil in the aggregate has very little fertility. Since the Mexican Revolution the mines have not been worked, the country being too much infested with Apache Indians. It is probable that the government in the purchase had an eye upon these mines, but how far the country is to realize any return to its treasury for the ten millions, we are not able to see. It appears to be the policy to allow individuals to rush in and secure Mexican titles to the land, and the Government generously contents itself with doing its military duty against the Indians. Under these favorable circumstances the Sonora Exploring and Mining Company originated about a year ago, and its first Annual Report is before us. Last year the Company sent out an armed expedition under the command of Col. Charles D. Poston, which reached Tucson in the latter part of August, where it was met by Mr. Ehrenberg, the geologist, who has directed its mining explorations. Being relieved from the danger of Indian hostilities by the arrival of Major Stein with four companies of U. S. Dragoons, the miners established their head quarters at Tubac, the centre of the old mining operations. The Report says:

The attention of the party was first directed to the Santa Rita Mountains, where indications of ore were found. These, being traced up, led to the discovery and occupation of the old works known by tradition as the Salero and Ojero mines, and to the discovery of twenty-two new veins of silver ore in the same mountains; all of which were at once occupied, and measures taken to give the company a legal title to the same. A permanent camp was established, and miners set immediately at work cleaning out the old shafts and opening new ones. According to tradition, the last attempt to work these mines was thirty-five years ago, when the whole party were killed by the Apaches. Their ruined huts still remain, and attest the fact of their occupation. The mines were said to yield ten per cent. of pure silver. The Salero (salt cellar) mine took its name from the incident which gave rise to its occupation. When the Bishop of Tumacacori, a mission three miles south of Tubac, came to take charge of his diocese, he complained much of the hardships he had to undergo in this northern province compared with the luscious fare and rich viands of his former residence at the south, and one day at table said he had not even a salt cellar to hold his salt. One of his zealous parishioners said, "Wait until next Sunday and I will bring you one." He immediately took to the mountains, and fashioned a rude salero from the silver mine in the Santa Rita Mountains, which in due time graced the Bishop's table, and gave its name to the mine. The Ojero owes its name to blue spots in the ore, resembling the blue under the eyelid. One of the new veins upon which work has been commenced contains lead with the silver, and is said to be rich. In consequence of the want of suitable chemicals, no accurate assays had been made; but the blow-pipe tests of the scientific gentlemen, who accompanied the expedition, show that these ores will well pay the trouble of working them.

The fine old ruins of the mission of Tumacacori show this to have been an important point with the Spanish Jesuits who first opened these mines. The company immediately set to work building a muffle oven, and it is now in blast and works to their entire satisfaction. From the small amount of rubbish found on the outside of the mine the party were led to believe that the shaft had not been driven to any great depth. Advices as late as the first of January, however, state that the miners had reached a depth of sixty feet, and were not yet to the bottom. The vein held good and regular. We are,

therefore, led to infer that the ores taken out were rich enough to warrant transportation, and were nearly all taken away from the mine for the purpose of smelting, in which case the propriety of going to the bottom would be all the more evident.

The company has also purchased from the Mexican owners the Arivaca Ranche, twenty miles west of Tubac, containing 17,000 acres of land and "twenty-five well known silver mines." It is thus in possession of 49 silver mines, old and new, from which it estimates an annual yield of $10,000 each by proper working, or $490,000 per annum.

MISCELLANIES.

COMPOSITE METAL.

E. A. Chamervy, Paris. Patented January, 1853. This invention relates to an ingenious system of manufacturing a commercially valuable metallic compound, possessing the several properties or qualities of solidity, hardness, facility of soldering, melting at low temperatures, and tractability in moulding to any required form, whilst its nature is peculiarly unchangeable. As the base or chief ingredient of this compound, Mr. Chamervy employs pounded or reduced iron ore, or reduced cast iron, or other metal difficult of fusion. Such matters are squeezed or pressed together into a solid mass, which is then soldered, so as to incorporate the particles well together, by the use of ore or more metals easily fusible at low temperatures, such as tin, lead, zinc, and bismuth: and in order to prepare this compound metal, the patentee employs a furnace fitted with a damper for the regulation of the heat at pleasure, and on this furnace is placed a caldron or metal receiver to hold the materials. One part of some very fusible metal, either a mixture of lead or tin, or any other metallic compound possessing the property of fusion at low temperatures, and of tinning over and soldering a metal less easy to fuse, is now placed in this caldron and melted. To this molten metal is then added about four parts of the pounded iron or pounded cast iron, steeped in a solution of ammonia or chlorine, or other preparation capable of cleansing the metal. The mass is now well mixed together, so that the particles of iron may be well tinned all over, taking care to regulate the fire, so that oxidation shall not ensue. When so treated, the mass is fit for use, and it may be poured into moulds for being shaped into a variety of articles; such, for example, as statues, columns, candelabra, fountains, and the like; as well as into cylinders, fly-wheels, pulleys, and other details ordinarily cast in moulds. As this compound melts and cools down very rapidly, moulds composed of cast iron, copper, or other hard metal may be used, so that the articles cast in this way may be turned out smooth and sharp, without requiring to be subsequently dressed. And as the metal is also malleable, it may be cast into plates of any required thickness, and then passed between rollers for mechanical reduction, in the manner of rolling out ordinary boiler plates. Such plates are principally intended for roofing houses, and for general covering purposes; but they may also be employed in the manufacture of tubes, tanks, and sheets for various uses. The crude metal may also be run into pigs in the usual way, and sold in that state for the usual casting or other manufacturing purposes.

ECONOMY OF FUEL—THE BAKER FURNACE.

Most intelligent persons, without special practical knowledge on this subject, seem to suppose that the economy of fuel in the production of steam has been carried to perfection, or rather to pluperfection, for they have read so often of the saving of 20 per cent., 30 per cent., and 40 per cent. by successive

inventions, that they can hardly fail to believe the entire sum of the savings must exceed 100. These people, who include the stockholders in our railways and manufacturing establishments, would be astonished if told that, with a few insignificant exceptions, fuel is wasted under boilers worse than when the steam giant began to work under the eye of Watt. Yet such is the fact. The modern engine does more for the same amount of steam, and thus a large saving has been made in general practice. To effect this result science and mechanical skill have done their best, amounting almost to miracles. Capital, too, has been poured out like water on myriads of costly experiments. On the far easier problem of effecting a maximum of vaporization with a given amount of fuel, comparatively little of time, talent, mind or money has been expended, and what is still more astonishing, even the success achieved by this little seems thus far to have been in vain as to any general acceptance. There is the highest solicitude to get the greatest effective force out of every pound of vaporized water, joined with the utmost carelessness as to whether a pound of fuel vaporizes more water or less. The old wagon boiler, used by Watt, would produce an evaporation of 6 or 7 lbs. of water for every pound of fuel consumed, and the world seems contented with that still—yes, more than contented, for it perseveres in preferring the slow evaporation in spite of the smoke nuisance which is inseparable from it, which covers the whole population with ashes, converts their broadcloth to sackcloth, and fills their eyes with tears. Yes, the murky atmosphere of almost every populous city in the world, is witness that about thirty or thirty-five per cent. of all the fuel used for manufacturing purposes goes into soot and smoke, instead of going as it might to increase dividends.

This is not because science has not discovered the laws of combustion, or because inventive skill has not devised the means of applying them to steam boilers so as to effect a combustion nearly perfect. For years it has been easily practicable to produce an evaporation with a stationary boiler as high as 9 or 10 lbs. of water for every pound of fuel, leaving the residuary gases that escape from the furnace without a trace of combustible matter, and at a temperature but little above that of the steam. Yet, either because the means were so simple that people could not believe the result, or because they thought that what was so easily secured they could themselves attain in some way to evade the patent, the furnace that really *burns up the fuel where the heat produces the most steam* has not yet come into general use—in fact is almost out of sight behind a hundred ephemeral experiments of which we read from time to time in the newspapers. The steam world, whether stationary or on wheels, puffs and whirls away, as if no such thing had been achieved, and complete combustion were as fabulous as "perpetual motion." Still we see the hard working engine taxed to blow its own fire till the flame belches from the very chimney top, and wastes its caloric on the blue sky. Compared with the nicely calculated motions, "cut offs," and condensing apparatus of the engine, the rudeness of the furnace and the recklessness of the feeding is quite astonishing, as we have already said, and we cannot sufficiently wonder at it. But we will contribute our best endeavors, line upon line, to diminish it.

Combustion is the union of the carbon and hydrogen contained in the fuel with the oxygen contained in the air, and the fact that this union produces or rather liberates heat which can be transferred to the water and convert it into steam, is what makes it available as a cause of motion. The heat must not be transferred too rapidly to the water, because it is needed on the fuel itself to put it in a condition for combustion. A sufficiently high temperature of the fuel and an adequate supply of air or oxygen are both necessary to complete combustion. And in a practical point of view we may add that *time* and *agitation* are also necessary. If the mass of fuel in the furnace were all at the temperature of ignition, and air could be injected instantaneously to every point, we should have a complete combustion, amounting in fact to explosion. But if the air were only partially supplied in such circumstances, the greater part of the fuel would be distilled or sublimed over, combustible without com-

bustion. At least it would pass unburnt through the flues, and if its temperature should keep up to the point of ignition would burst into flame on coming into contact with the air of the chimney top, otherwise not. But the mass of fuel in the furnace is at first below the temperature of ignition. The heat of the incipient combustion gradually raises it to that point, and while this process is going on, there must of course be some distillation at a temperature too low for complete combustion, especially considering the mixed character of the gases and the watery vapor from the fuel. But when the whole mass is raised to ignition, then, as air can only be supplied superficially, there must be *time* and *agitation* to effect the entire combustion of the combustible gases and sublimed carbon that have been liberated by the heat.

To secure these two conditions there must be either sufficient length of flue or slowness of current to keep the ignited combustible matter in contact with the steam-producing surface till the combustion can take place, which will be effected the sooner by a thorough intermixture or stirring up of the supporters of combustion with the combustible. Chemical combination generally requires contact, and is almost always expedited by mechanical agitation. Now it is quite impossible to bring air in contact with all parts of any mass of incandescent fuel, therefore more or less distillation must take place, and the only resource for complete combustion is to bring air in contact with the products subsequently. If this can be done while the temperature of the carbon and gases is up to ignition, and with air which is also heated, the great object is secured.

A variety of expedients have been resorted to to secure the practical effect of these well known chemical laws in furnaces, but that which has been most thoroughly tested and which seems to have awakenened inventors to this line of effort, without leaving them any considerable margin for improvement, either in simplicity or efficiency, is the one patented by Col. Henry F. Baker, some eight or nine years ago.

We have little doubt that this simple and unexpensive improvement has done and is doing more smoke-burning than all other contrivances put together, and doing it as well as the costliest, yet compared with the whole consumption of coal, it is doing and has done nothing to speak of. How is this? At a moderate estimate we may value the coal consumed in furnaces for the last eight years in this country alone at $240,000,000, and of this one-third, or $80,000,000, have gone off in fuliginous exhalations, to do nothing but damage lungs, complexion, health, comfort, and beauty of all sorts. Yet there have been on record facts and experiments, of an unquestionable character, to show that "Baker's Improvement" might have saved at least sixty out of these eighty millions worse than wasted. The only reasons that occur to us for this remarkable backwardness to accept an improvement of such immense public importance, are its extreme simplicity, like that of the prophet Elijah's prescription for the cure of leprosy which so discouraged Naaman the Syrian, and the interests of boiler and engine-builders, who have no motive to forward improvements which do not enlarge their own resources, and whose advice is generally law to their customers.

The simplicity of the Baker improvement is indeed remarkable. Instead of allowing the gases to proceed directly through the flues, in which case, if air should be supplied during the progress, the flues must be greatly extended to secure a complete combustion, Col. Baker introduces one or more curved bridges which have the effect to set the current into a series of reverberations or eddies, which not only increase the *time* of the passage in the ratio of the circumference to the diameter of a circle, and secure necessary *agitation* to mix the air with the combustible, but cause the flames to impinge on the steam surface. Any one who has ever used a blow pipe-and knows that the highest intensity of a flame is at its apex, will see the importance of this arrangement. In a straight, continuous sheet of flame, the sharpest darts of caloric glance by the steam surface, whereas when the sheet is broken up into a series of rolls, revolving on horizontal axes, the intensest darts are shot up into the water as if by centrifugal force. But, however it may be account-

ed for, there is no doubt of the fact of the greatly increased effect given to the flame by this introduction of curved surfaces.

Mr. Jonathan Amory, agent of the Company which now holds the patent for this improvement, has added to it the introduction of heated air at the curves behind the ignition, in such a way as to make the furnace highly applicable to the coal-burning locomotives. It is in this regard that we take a deep interest in the improvement, and shall earnestly watch the result of experiments now in progress further to test its value in this branch of the steam service. Whatever may be the value of more recent or more elaborate inventions for consuming smoke, and we doubt not many of them will be found good, we are satisfied that this simple one, with any thing like fair play,—an advantage which it has sometimes failed to enjoy,—will not only demonstrate the economy of coal-burning locomotives, but carry the evaporation so high as sensibly to enhance railway dividends. And we ask those of our readers who feel interested in this particular branch of the railway subject, to look beyond all unprogressive *dicta*, and weigh carefully what we shall have to say from time to time on this and other modes of securing perfect combustion. —*Railway Times.*

DISCOVERY OF COAL AND IRON IN MISSISSIPPI.

This city has long been dependent for its usual supply of coal upon that shallow and fickle river, the Ohio, which subjected our citizens to the frequent necessity of paying the most exorbitant prices for fuel, for no other reason than that the said river contained too little water or too much ice to admit of navigation. But we are glad to see signs that promise a radical breaking up of that untoward state of things, and that speedily. The public has already had an inkling of the discovery of an extensive coal mine at an accessible and not distant point, near the Ouachita River, in this State; and we have just been assured that a similar discovery has been made in Mississippi. This last mine of coal is said to be situated near the Big Black River, on the dividing line between Claiborne and Hinds counties, about eighteen miles east from Vicksburg, and about the same distance from the New Orleans and Jackson Railroad. It is thus accessible by railroad, to within a short distance, and by the Big Black River, which is represented as navigable to that point all the year round.

This mine is on the lands of Dr. J. W. Hutchins, whose post office is Cayuga, Hinds county, Miss., where he can be addressed by manufacturers who want to buy coal for use, coal-merchants who want it for speculation, or capitalists who wish to embark in extensive coal-mining operations in the South. As stock companies are all the agony in the financial world, at present, and the "bulls" are having a fine time of it in unlimited clover, we hope Dr. Hutchins will not be unyielding to the solicitations that may be expected to pour in upon him to make his coal mines the basis of a *bona fide* and highly marketable stock.

But coal is but a part of the mineral and other treasures discovered on these lands. The stratum of coal, which is about four feet thick, is said to be interspersed with rich veins of iron ore, and both of these articles were discovered in digging a well which contains the finest chalybeate water. On the same ridge of land in which these discoveries are made, Cooper's Well and Mississippi Springs are situated. It extends through Claiborne, Hinds and Madison counties, and has been long known to be rich in iron ore as well as other minerals.

Thus we see that geography and geology both combine to furnish an abundance of the most needful elements of commerce, manufacture, and internal improvement, almost at our doors. Nothing but intelligent enterprise is wanting to bring to a brilliant completion what nature has so lavishly begun. When shall we have the organization of the Ouachita and the Big Black Coal Mining Companies? Had not the two better be consolidated into one? We merely make the suggestion for the consideration of all parties interested.—*New Orleans Delta.*

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